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ABRIDGED AGRICULTURAL RECORDS
IN SEVEN VOLUMES

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THE EXPERIMENT STATIONS

26905

A Compilation of such Bulletins and Reports
as are Indispensable to the Practical Farmer

VOLUME V

FRUITS, FORESTS, FLOWERS, COTTON, TOBACCO, SUGAR BEETS, SUGAR CANE, ETC.

GARDEN CITY NEW YORK
DOUBLEDAY, PAGE & COMPANY
1914

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HORTICULTURE, FORESTRY, FLORICULTURE, ETC.

PART I

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HORTICULTURE.

INTRODUCTION.

"FRUIT GROWING, although one of the most important branches of agriculture, has not had that careful attention on the part of the ordinary farmer that the value of fruit as a farm crop justifies. This has been due largely to a lack of appreciation on the part of the farmer of the possibilities of this crop as a source of income and for home use and to ignorance of the methods by which fruit culturists have succeeded. It is hoped that the course herewith submitted will be of direct practical value by placing within the reach of the ordinary farmer opportunity to study the subject of fruit growing under the teaching of an expert with a view to his making it a remunerative feature of his system of general farming, and that it may also enable others who wish to specialize in fruit growing to select suitable varieties, cultivate, fertilize, prune, and care for the trees properly, and at the same time utilize for the purpose cheap or waste land."—(A. C. TRUE, Director of Experiment Stations, U. S. E. S. B. 178.)

FACTORS THAT MAKE UP A GOOD FRUIT-GROWING SECTION.

Accessibility.—By this is meant railroad and other communication, and not only nearness to market but the possibility of getting suitable transportation service at a reasonable rate. Water communication is often better than rail, especially for kinds of fruits that are easily injured by rough handling. Accessibility will not entirely take the place of suitable soil conditions, although it does sometimes make profitable the use of an inferior soil. Good wagon roads render it possible to get to the railroad station or to market quickly with large loads of produce in good condition. This is a very important consideration in the profitable development of any fruit section.

If the location is so far from the consumer that the produce must be shipped by a common carrier, it is important that fruit enough be grown in that section to make the business of handling and shipping it of sufficient importance to command special attention from the carrier and from buyers; in short, to make it a place where buyers will go for fruit. In starting fruit growing in a new place, especially where remote from market, the pioneers are often under the disadvantage of not having enough of their product to make it worth while to ship it. This difficulty can be overcome by starting the industry on a scale large enough to insure that shipments can be made in carload lots.

Soils.—The only safe way to determine the value of a soil for a particular fruit is by actual trial. So many factors enter into the determination of the character of a good fruit soil that it is easy to be mistaken in judging of its adaptability for fruit, and yet the best fruit soils have many points in common. There is hardly a soil that will not be found adapted to some class of fruits if the conditions as to drainage, exposure and fertility are favorable. For instance, the pear prefers a rather heavy clay soil, the peach and cherry quite open and porous soils. The strawberry and blackberry will often do well on soil too sandy for other fruits. The currant and gooseberry prefer an open clay loam, but will adapt themselves to almost any location. Then there are locations so wondrously adapted to special fruits that it seems impossible to raise them in equal perfection elsewhere. Such are the lands adapted to the Albemarle Pippin in Virginia.

The great variety of fruits grown within the limits of the United States and the wide range in requirements for both soil and climate exhibited by the different varieties of the various species of fruit-producing plants render the characterization of any particular soil or of any class or group of soils as special fruit soils impossible. In general it may be stated that all soils to be well adapted to the production of the majority of deciduous tree fruits must be characterized by good natural drainage; by level or rolling topography, not precipitous; by a considerable depth of surface soil and subsoil and by relative freedom from large stone or bowlders which might interfere with cultivation. When these inherent properties are present there are necessary also certain conditions of protection or exposure, of altitude and latitude, and of accessibility in order to render advisable the selection of any particular field for extended fruit culture.

The investigations of the Bureau of Soils, while not particularly directed to the study of fruit soils, have shown that the ideal soil for the production of a particular class of tree fruits, as apples, peaches, pears, cherries, or plums, varies in different sections of the country. Thus the typical apple soils of New England, New York, the Appalachian belt, the Piedmont section, the prairie region of central Illinois, the Ozark belt of Missouri and Arkansas possess in common the characteristics of adequate soil drainage, reasonable porosity, and sufficient ability to maintain moisture to insure against damage from drought. In origin, in altitude, in texture, and in topographic distribution they not only differ markedly, but there is every indication that different varieties of apples in the same general fruit region are not all equally suited to the same type of soils.

A review of the general characteristics of soils upon which tree fruits are produced in some of the best-known fruit districts, as revealed by the surveys of the Bureau of Soils, shows that orchard fruits in general require good natural drainage, a fairly friable soil and subsoil, and a sufficiently loamy soil or subsoil to retain a good moisture content. It is also apparent that neither hardpan nor underlying rock should exist at shallow depths to prevent free root development and proper drainage. It is also evident that different varieties of apples, of peaches, or of other tree fruits are adapted to somewhat different types and classes of soils, and particularly that with variations in climate, topography, and other features of environment the type of soil suited to a particular variety of a particular fruit may, in fact must, vary between different regions. Generalizations from limited areas can not be safely extended to other regions where the soils are not only derived from different parent materials but have been formed by different processes and lie under different conditions of climate, exposure, topography, and drainage. There should also be observed the fact that in a single class of fruit, and strawberries form a notable example, proper selection of varieties will insure the securing of at least one or more varieties adapted to the soil existing on a given farm under ascertained climatic conditions. It is thus not a question of strawberry soils but one of a soil suited to produce a definite variety under fixed surrounding conditions.—(U. S. E. S. B. 178.)

Modification of Soil.—Since one does not choose the site of his residence on account of the character of the soil of the locality, but because of other natural advantages of the place, it is obvious that the soil at the disposal of the grower will frequently be ill-suited to the purposes of a home fruit garden. For a commercial place on an extensive scale it would be out of the question to attempt to alter the character of the soil to suit the needs of the plant, but with a small area the case is quite different. If the soil is heavy it can be lightened with sand if it is not desirable to increase the proportion of humus which it contains; if it is lacking in organic matter the addition of leaf mold and well-rotted manure or the turning under of some leguminous crop, such as cow-peas or Canada field peas, will accomplish the desired result; if the soil is loose and sandy, losing its store of plant food readily, this fault can be remedied by the addition of retentive material, such as clay; the amount of clay to be added must be governed by the degree of stiffness desired in the soil. If, on the other hand, the class of plants to be generally grown is suited to a loose, sandy soil, and it seems desirable to add to the collection a plant, such as plum, which naturally requires a heavy, retentive soil, it would undoubtedly be better to change the character of the plant by grafting it upon a stock adapted to sandy soil conditions than to attempt to modify the soil to suit the plant. This change can be effected by using a peach stock for the plum. There are therefore two alternatives—either the soil may be modified to suit the plant or the plant may be adapted, by working it upon a suitable stock, to the soil. Such modifications in plants are not always easily accomplished, and with many plants there is no alternative but to use them on their own roots. In this latter case the soil itself must be made to conform to the demands of the plants. The soil, in addition to being heavy and retentive, may also be cold and wet. In such case the addition of sand will not entirely overcome the difficulty.

Sand will lighten and facilitate natural drainage, but if the soil be unduly moist the only safe and satisfactory remedy lies in thorough underdrainage. This can be accomplished in two ways: Drains may be dug and a stone conduit built to allow the superfluous water to escape, or, what is better, agricultural tile may be laid in the bottom of the trench. If the soil is very stiff and retentive, the tiles should not be laid over 2½ or 3 feet deep and about 1 rod apart. If the soil is porous, the drains may be placed farther apart and buried deeper. A double purpose is served by underdraining. The superfluous water which tended to make the land cold, sour, and "late" is removed, thus making the soil warmer and earlier; and by the admission of air the acidity is slowly overcome. The processes of oxidation and nitrification are also afforded better conditions for action, and while drainage adds nothing to the soil in the way of plant food, the mechanical operation of removing water and admitting air is quite as marked in its effects as a liberal dressing of manure, for the store of plant food which was withheld from the plant is allowed to become available. There is little wonder in the light of these facts that early agricultural writers propounded the axiom, "Tillage is manure."—(F. B. 154.)

TOPOGRAPHY.

A rolling country is very certain to give good water drainage. This is of first importance, for our cultivated fruits, with the exception of the cranberry, are injured by a surplus of water. Such a country also affords more elevations where there is comparative immunity from frosts. For these reasons, good fruit growing sections are generally found where the land is hilly or rolling. But when near large water areas so that there is secured comparative protection from frosts and when sufficiently elevated to secure good drainage, land that is quite flat may sometimes prove good fruit land.

Fruit Growing as a Business.—Success in any business is largely a matter of individual capability, and success in fruit growing likewise depends much on the capacity of the individual and upon his adaptability. The demand for fruit is increasing. The consumption of fresh fruits is now greater per capita than it was a few years ago. With the introduction of improved methods of storing and shipping, fresh fruit is destined to play a more important part in the diet of every American. Comparatively few years ago fresh fruit was regarded as a luxury, now it is regarded as a necessity, both for nourishment and for its hygienc value.—(U. S. E. S. B. 178.)

The successful fruit grower must be well informed respecting the principles that underlie the growing of fruit, that he may be able to solve the many problems that are sure to arise in the course of his experience. It is important that he know not only how to grow fruit, but he must also know how to market it. In other words, he must be a good business man. Some of the most successful fruit growers and horticulturists have been men who were not reared to the work, but have taken it up late in life and have succeeded largely because of their business ability. It is not to be inferred from this that farmers' sons do not make good farmers, but that they often fail to get the most out of their farms owing to their lack of business training. The fruit industry requires for its successful promotion men of ready resources and accurate knowledge who can quickly comprehend and adapt themselves to varying conditions.—(U. S. E. S. B. 178.)

Small-Fruit Culture.—The growing of small fruits requires a comparatively large investment of capital per acre and also a better soil than is necessary for the production of most of the tree fruits. It is therefore better suited to the small farm, under the direct supervision of the owner, than to the large estate, whose proprietor cultivates by proxy. To balance the comparatively large capital required there is the fact that, aside from the value of the land and permanent improvements, the chief outlay is for labor, which may be done by the grower and his immediate family, while the returns are much quicker than from the tree fruits or the grape. In a few sections, so situated that large markets, either near or remote, are accessible, the culture of one or another of the small fruits may be profitably undertaken on a large scale, but these instances only serve to emphasize the fact that small fruit culture is primarily a homestead pursuit. The narrow bed or garden border of fifty years ago, enriched, dug and weeded by hand, has developed into the field, fertilized, plowed, and cultivated by horse power, yet the requirements of the various species remain much the same, the methods of accomplishing the desired results alone differing. As practiced by advanced growers in the United States, the methods followed in the culture of small fruits are peculiarly of American development; while with the exception of the currant, the varieties extensively grown are of American origin.—(Y. B. 1895.)

MARKET CONDITIONS AND FRUIT SUPPLY.

The fruit market, which has been greatly expanded in recent years, has been very greatly modified and extended by improved methods of transportation and storage. A man need not be very old to remember the time when, at least in the Northern States, bananas were a comparative rarity outside the large cities, and oranges and lemons, though common commodities, were rather high in price. In the summer there was an abundance of the common garden fruits, but in winter apples were practically the only sort which was at all plentiful. A few years have witnessed a great change, and now there is hardly a village so small that bananas and other southern fruits can not be purchased at reasonable prices. In Europe the situation is much the same. Such quantities of bananas are now taken to England and sold at such reasonable rates that they are sometimes spoken of there as the poor man's fruit. At the present time there are a number of fruits, such as avocados or "alligator pears," mangoes, and sapodillas, which are fairly well known in the large markets though seldom seen in the smaller towns. The enormous development of the fruit-growing industry in California and Florida, which includes the products of both temperate and warm regions, as well as the possibilities of supplying the northern markets with tropical fruits from Porto Rico and Hawaii, makes it probable that within a few years the avocado, the mango, and other tropical fruits will be as well known as the pomelo or the pineapple.

Improvements in transportation have also materially lengthened the season of many fruits, such as strawberries, which can not be stored for any considerable period. Florida and the Carolinas now send their berries to Northern markets months before the home-grown crop can be expected and several weeks before that from tide-water Virginia or New Jersey is ripe. As an illustration of the effect of improved methods in shipping fruit, it may be mentioned that melons from the south of France, hothouse peaches from Belgium, and peaches, plums and other fruits from South Africa are now sent to our American markets in winter. The introduction or origination of new varieties of fruits also prolongs the season. As an instance may be cited the Peen-to peach, a Chinese variety which can be successfully raised in Florida and Texas, and which is found in our Northern markets in early spring, though at present at prices which clearly make it a luxury. Furthermore, improved methods of culture and transportation have extended the area planted to old and well-known varieties.—(F. B. 293.)

Precooling of Fruit.—Precooling has become a very important factor in the transportation of fruit. To the grower and shipper it is important as a means of extending the marketing area of the product by assuring its delivery in sound condition over long distances. To the carrier the sound condition of the fruit is an important consideration, but mainly from the traffic standpoint. Precooled fruit may be loaded more closely and heavily, thereby increasing the carrying capacity of the cars, and less ice will be consumed en route. But whether the reduction of the initial temperature is properly the function of the shipper or the carrier is still an open question.

As an adjunct to careful handling in preparing fruits for market, precooling will materially assist in minimizing losses from decay and deterioration in transit. It is in no sense a panacea for all the difficulties of carrying fruits in sound condition to distant markets. It can not improve the quality or condition of the product packed and can only temporarily retard decay following injuries made by rough handling; but it renders unnecessary the packing of such fruit as peaches, plums, and apricots in a hard, green condition in order to offset the ripening which takes place in cars under ordinary icing methods. It reduces the differences frequently occurring between the top and bottom tiers of the load by equalizing temperature conditions within the car.—(Y. B. 1910.)

Overproduction of Fruit.—Occasionally there is an overproduction of fruit, but it is usually of inferior quality. It rarely occurs that there is an overproduction of choice fruit. One great difficulty with which the fruit grower has to contend is in the methods of fruit distribution. Because of lack of system in this respect consumers are often unable to get the kind and quality of fruit they want, although there may be an abundance in the country. The tendency of the market is in the direction of cheaper fruit, while at the same time there is a growing discrimination in taste as respects its quality and appearance. The number of consumers who are willing and able to pay a fair price for a superior grade is fast increasing, and as population and wealth increases this discrimination in favor of the best will become even more pronounced than it is today. Those fruits are most stable in price that can be readily used for canning or drying, since when low in price the surplus may be readily disposed of to the local factory.—(U. S. E. S. B. 178.)

PROCESSES FOR SAVING THE CROP.

The several processes which are now in use and regarded as efficient to preserve a crop and put it in commercial form are: (1) Sun drying or evaporation with artificial heat; (2) Canning; (3) Extracting of the juice.

If a plantation is too remote from a market or a preserving factory to justify carriage of the fruit, it will be necessary to work the entire crop at the plantation into concentrated commercial form through the use of one or all of the processes above mentioned. In some localities all the product of an apple orchard, excepting the first-class fruit (which will generally find a ready sale), may be profitably worked into cider for beverage uses and into vinegar. The product of peach, pear, and plum orchards, in case the first grade does not find ready sale in its natural state, can be saved from waste through the processes of evaporation and canning. The product of small fruit plantations, being quickly perishable, requires immediate disposition, either in its natural state or preservation by evaporation and canning to prevent losses. In seasons of great fruitfulness there generally occurs a glutted market, and despite the best efforts of agents and commission houses some large shipments are lost in part or in whole which might be saved by evaporation and canning.—(Y. B. 1898.)

Utilizing the Fallen Product.—Through the attacks of insects, which become numerous in some orchards, and through violent windstorms and severe droughts, a portion of the product will prematurely fall and be wasted unless means are used to save it. This fallen fruit is unfit for any purpose except for swine food, and it is therefore advisable to turn hogs into the orchard to forage upon it, thus converting it into a food for an animal having a commercial value, and at the same time causing the destruction of the infesting insect larvæ and preventing the future increase and spread of such damaging agents. Thus, it will be seen that there is no necessity for any waste occurring in any portion of the product of an orchard under economical management, as all parts of the fruit may be profitably saved by the several methods presented. What has been said has been more especially in regard to saving the product of the smaller or family orchard, but the principles involved are the same whether applied to large or small establishments, and the means may be provided according to the necessity of the larger or smaller operation.—(Y. B. 1898.)

Choice of Locations.—Most persons who are making a specialty of fruit growing and many farmers who contemplate changing from general cropping to fruit growing are so held by social ties, land incumbrances, and in other ways that they can not easily change their location. The matter of location is for them a settled question. If they are to engage in fruit growing at all, it must be in their present location and surroundings. To them it is a question of crop selection, crop location, and methods of management best suited to their conditions. If, as they are situated, fruit growing can not be made to pay, they had better devote their land to other purposes.

On the other hand, there is a small class of people who wish to grow fruit who are free to change their location. For such it is a good plan to visit some successful fruit sections and thoroughly study their conditions and probable future before locating permanently. In making such a study it is well to take plenty of time before finally concluding to locate, as there are many factors to be considered. It is usually unwise for a grower to change from a line of fruit with whose production he is thoroughly acquainted to one that is unfamiliar. Occasionally it may be desirable or even necessary to make such a change, but in any case it should be made with the greatest caution. The successful apple grower of Missouri may become a successful orange grower in California after he has had experience, but he will have much to learn before he can do so. The man who is starting anew in the growing of fruit of any kind should start in a small way and not risk too much on a single venture.—(U. S. E. S. B. 178.)

OPPORTUNITIES IN INTENSIVE FRUIT GROWING.

The subject of intensive fruit growing and the splendid opportunities on the Pacific Coast—in California, Washington, and Oregon—come to one's mind. The possibilities of success have been so great, however, that many of the best locations have already been utilized and the business is highly developed. Unfortunately, the great distance from market furnishes an obstacle to profitable orcharding which at least partly offsets the natural advantages. In Colorado, on the western slope of the Rocky Mountains, as well as in adjacent parts of Utah and New Mexico, fine opportunities await the energetic and skillful orchardist. Young orchards are being planted out at a rapid rate, and the product is, as a rule, of the highest commercial quality. The wax-like apples produced in this region, neatly packed in bushel boxes, attract buyers from nearly all the Eastern States, who paid last season prices ranging from 50 cents to over $1 a bushel for this fruit delivered at the railway stations. The future development of the apple industry in this region seems almost unlimited. Peach growing in the western Rocky Mountains is especially successful, and the output is increasing rapidly. Some of the very best sections are just now being extensively opened, and a good deal of fruit land just being brought under irrigation can be purchased at moderate prices. However, the success of this industry has caused the value of the orchard lands in convenient locations to rise to a point that astonishes the eastern visitor. Some of the finest apple orchards are valued at over $1,000 per acre.

Around most cities from the Mississippi Valley eastward there are localities naturally fairly well adapted to the growth of tree fruits. Every city of 5,000 inhabitants or more constitutes a fair market for at least one moderate-sized fruit farm. The larger cities of 25,000 people and upward, of course, offer the most attractive localities. A well-planned orchard, better still, if accompanied by a plantation of small fruits and berries, can be made extremely profitable by catering to the local demand. As a rule, if the fruit is grown in large quantities it is better to sell it to greengrocers and dealers, but where the grower is prepared greater returns can, of course, be secured by marketing in a retail way.

Particularly fine opportunities for growing fruit for the local markets occur in New England. In the rush to make money out of manufacturing and trade, a large proportion of the capable young men in New England desert the farms. There are at the present time as good opportunities for brains, energy, and capacity for work to reap their reward in peach growing on some of the Connecticut hills as anywhere in the country. Frequently beautiful unused orchard sites overlook manufacturing towns having a population of from 20,000 to 40,000 people. Since the scourge of pear blight has now spread across our country to the Gulf on the south and to the Pacific Ocean on the west, it is well to look around and decide which region has the least trouble from this serious pest. New England and the Lake Region suffer less from pear blight than any other sections of the country in which pears can be successfully grown. A well-managed pear orchard in the vicinity of Boston, or at some other convenient point in southern New England or certain sections of New York State, and perhaps Ohio and Michigan, would be more likely to succeed than in any other part of the Union.

The largest area of undeveloped fruit country in the United States is the Allegheny Mountain region. In Maryland, Virginia, West Virginia, and North Carolina—in other words, the central Allegheny section—there is one of the finest horticultural regions in the country. By far the larger part of this is totally undeveloped. Mile after mile of beautiful mountain slopes in West Virginia are totally unoccupied by fruit plantations. This region not only has a fertile soil suitable to tree growth of all kinds, but it grows bright-colored, highly flavored fruits, especially peaches and apples, of excellent shipping qualities. They nearly always sell, when well grown, for the very highest market prices. Choice dessert apples like Grimes Golden, Rome Beauty, Winesap, Northern Spy, and, in the higher altitudes, Spitzenberg, grow readily in this region. It extends northward well into Pennsylvania and southward, as far as peaches are concerned, into north Georgia and Alabama. The mountains of North Carolina are the southern limit of good apple culture in the East. A certain section of Virginia, within this region, grows to perfection the famous Newtown Pippin, which is marketed under the name of Albermarle Pippin, the most exacting in its requirements of soil and climate of all commercial apples. Much of this land is very rough and rocky, although the soil is fertile and highly adapted to tree fruits. The stone fruits (peaches, Japanese plums, and cherries), as well as apples, pears, and quinces, thrive in this section.

In the lowlands along the coast tree fruits do not do so well south of Maryland. From Maryland northward fine peach orchards have been developed in the tidewater region. However, the growing of strawberries, cantaloupes, and early garden truck can be made very profitable from Florida all the way up to New Jersey if the right man takes hold of the work. The location of these early truck farms should be determined by nearness to market or to transportation lines, earliness of location, and protection from spring frosts. There is a succession of these products marketed through the spring and summer, beginning in Florida and following successively up the coast to New York or even farther north. A similar condition of affairs exists in the Mississippi Valley, beginning at the Gulf coast and extending through Mississippi and Louisiana to southern Illinois, ending in northern Wisconsin and Michigan.—(Y. B. 1904.)

CHOICE OF LOCATION FOR SMALL FRUITS.

No small fruit plantation or one that is desired for profit making is likely to be profitable if located far from a market or convenient shipping point. In selecting a location special attention should be paid to the character of the roads, if the fruit must be hauled by wagon for any considerable distance. If railroad or steamboat transportation is to be depended on, the efficiency and enterprise of existing lines should be investigated, as the character of their service will be of great importance when fruit shipments begin.

In any given locality the most important consideration should be the selection of a site reasonably safe from killing frosts in spring. Away from the influence of bodies of water such sites are usually found on small plateaus or gentle slopes terminating in abrupt ravines or valleys where prompt and thorough cold-air drainage exists. Flat land, remote from open water and unbroken by ravines or hills, should always be regarded with suspicion, particularly if underlaid by a cold and badly drained subsoil. Bottom lands, in which admirable soil for small fruits is often found, are usually too uncertain in their fruit production, owing to frequent frost injury. The soil requirements of the different species vary considerably, but all thrive in a moderately deep loamy soil that holds moisture well at all times without becoming soggy during protracted rainfall.

The exposure to be sought varies with the latitude, the climate and the aim of the grower. If earliness is requisite to secure profitable prices, and the locality one in which late frosts are infrequent, a southern slope is preferable; if, on the other hand, a uniform and regular demand exists, regardless of a few days' difference in time of ripening, a gentle northern or northeastern exposure should be selected. In most localities, however, the matter of slope is of much less importance than that of comparative elevation of the site. It should lie higher than the adjacent land without being bleak, and should furnish a soil of at least fair fertility.—(Y. B. 1895.)

The following lists of varieties, while made for northern Ohio, are presented more as a guide to the proportionate allotment of plants of various species in a home fruit garden than as a guide to varieties suited to such a garden. As has already been pointed out, the selection of sorts for a fruit garden is a local as well as personal matter.

Varieties give their best products only in certain more or less restricted areas, so the list of fruits in one section will naturally differ widely from those in another. Then, too, the personal likes of the planter will modify the list in each garden, even though the conditions be such as to admit of a duplicate set in each.

FRUIT GARDEN NO. 1 (ABOUT 2 ACRES).

APPLES (22 TREES).—*Summer:* Two Early Harvest, 2 Red Astrachan, 1 Golden Sweet, 1 Pumpkin Sweet, 1 Maiden Blush. *Winter:* Two Grimes Golden, 2 Baldwin, 2 Rhode Island Greening, 2 Belmont (White Pippin), 1 Fallawater, 1 Fameuse (Snow Apple), 1 Tolman Sweet, 1 Roxbury Russet. *Crab:* One Hyslop, 1 Transcendent, 1 Yellow Siberian.

PEACHES (25 TREES).—*Early:* Four Yellow Rareripe, 4 Early Crawford, 4 Elberta, 2 Alexander, 2 Canada Early, 1 Lewis. *Late:* Four Late Crawford, 2 Stephens Rareripe, 2 Golden Drop.

PEARS (10 TREES).—Four Bartlett, 2 Koonce, 2 Duchess, 1 Kieffer, 1 Seckel.

CHERRIES (10 TREES).—Four Allen, 2 Black Tartarian, 4 Early Richmond.

PLUMS (10 TREES).—Two Green Gage, 2 French Damson, 2 Lombard, 2 Mary, 2 Willard.

QUINCES.—Fifteen Champion.

APRICOTS.—Five Montezumet.

NECTARINES.—Five Boston.

GRAPES. (100 VINES).—Twenty-five Concord, 25 Campbell's Early, 25 Niagara, 25 Brighton.

RASPBERRIES (150 BUSHES).—Fifty Gregg, 25 Marlboro, 50 Cuthbert, 25 Golden Queen.

BLACKBERRIES (100 BUSHES).—Fifty Agawam, 50 Taylor.

CURRANTS (100 BUSHES).—Fifty Victoria, 25 White Grape, 25 Black Champion.

GOOSEBERRIES (75 BUSHES).—Twenty-five Downing, 25 Industry, 25 Columbus.

STRAWBERRIES (400 PLANTS).—One hundred Brandywine, 100 Glen Mary, 100 Warfield, 100 Gandy.

FRUIT GARDEN NO. 2 (FOR MEDIUM-SIZE PLACE).

APPLES (10 TREES).—Two Baldwin, 2 Grimes Golden, 1 Fallawater, 2 Red Astrachan, 1 Bonum, 1 Sweet Bough. *Crab:* One Transcendent.

PEACHES (10 TREES).—One Alexander, 2 Rareripe (Yellow), 2 Early Crawford, 4 Late Crawford, 1 Stephens Rarepipe.

CHERRIES (5 TREES).—Two Early Richmond, 2 Black Tartarian, 1 Allen.

PLUMS (5 TREES).—Two Green Gage, 2 Lombard, 1 Willard.

PEARS (5 TREES).—Two Bartlett, 1 Duchess, 1 Kieffer, 1 Seckel.

QUINCES.—Five Champion.

APRICOTS.—Two Montezumet.

NECTARINES.—Two Boston.

GRAPES (50 VINES).—Twenty-five Concord, 10 Niagara, 15 Brighton.

RASPBERRIES (70 BUSHES).—Twenty-five Gregg, 10 Marlboro, 25 Cuthbert, 10 Golden Queen.

BLACKBERRIES (50 BUSHES).—Twenty-five Agawam, 25 Taylor.

CURRANTS (45 BUSHES).—Twenty-five Wilder, 10 White Grape, 10 Black Champion.

GOOSEBERRIES (30 BUSHES).—Ten Downing, 10 Industry, 10 Columbus.

STRAWBERRIES (200 PLANTS).—One hundred Brandywine, 100 Gandy.

FRUIT GARDEN NO. 3 (FOR SEED LOT).

APPLES (4 TREES).—One Red Astrachan, 1 Golden Sweet, 1 Baldwin, 1 Fallawater.

PEACHES (4 TREES).—One Early Canada, 1 Yellow Rareripe, 1 Early Crawford, 1 Late Crawford.

PEARS (2 TREES).—One Bartlett, 1 Duchess (Dwarf).

PLUMS (2 TREES).—One Wilder, 1 Lombard.

QUINCES.—Two Champion.

APRICOTS.—One Montezumet.

GRAPES (10 VINES).—Five Concord, 5 Niagara.

RASPBERRIES (20 BUSHES).—Ten Gregg, 10 Cuthbert.

BLACKBERRIES (20 BUSHES).—Ten Taylor, 10 Agawam.

CURRANTS (10 BUSHES).—Five Victoria, 5 White Grape.

GOOSEBERRIES.—Five Downing.

STRAWBERRIES.—Fifty Brandywine.

—(F. B. 154.)

In 1909, the Bureau of Plant Industry, Department of Agriculture, issued a complete list of the "Fruits Recommended by the American Pomological Society for Cultivation in the Various Sections of the United States and Canada." The varieties of fruits included in this Bulletin (151) have been recommended and rated by practical growers, who have tested them in various sections of the country, and these lists can not fail to prove of value to the planter who wishes reliable information as to what fruits will probably succeed in his soil and locality. Send for Bureau of Plant Industry Bulletin 151.

CULTIVATION AND COVER CROPS.

In a state of nature where trees do well they generally have the surface soil about their roots covered with a loose accumulation of vegetable mold which shields from the sun and wind, while the deeper soil is filled with roots more or less decayed tending to keep the subsoil porous. This covering protects the soil from drying out and furnishes the conditions aimed at in cultivation. Treatment in imitation of forest conditions has been unsatisfactory in that the shade precludes the light and air necessary for the production of perfect fruit. It also renders inconvenient access to the trees for gathering the fruit and for applying insecticides and fungicides to protect from noxious insects and diseases.

Implements for Cultivation.—For the first few seasons after the trees are set out and where cover crops are grown in the orchard fairly deep plowing and a plow heavy enough to completely turn under all the material accumulated on the surface will be needed. If there is but little matter to turn under, a lighter plow or even some of the better types of cultivators or harrows will suffice. On the heavier clay soils the first two or three cultivations in spring, when the soil is lumpy, should be done with rather heavy implements like the spring-tooth or other harrows, but later in the season when the object of cultivation is chiefly to conserve moisture by means of a dust mulch the lighter spike-tooth drags will more nearly meet the requirements. The present system of heading orchard trees low practically prevents the use of any tools for cultivation having high wheels or handles. The singletrees should be short and the ends covered with cloth to prevent barking the trees, or a traceless harness used instead. If the limbs are low, some one of the extension harrows now in use will prove very useful. Or if one has rather long whiffltrees any of the usual cultivators can be separated in halves sufficiently far apart to reach under the trees. The harnesses should be free from metal projections and there should be no high tops to the hames. Harnesses are now made which draw by a single chain between the horses and without whiffletrees.—(U. S. E. S. B. 178.)

With the modern tools for orchard cultivation this work can be done very thoroughly and cheaply. The work for a season has been variously estimated at from $10 to $25 per acre. In plowing an orchard that has been long in turf, the greatest care must be taken not to cut and tear the large roots and to plow only three or four inches deep, using shallow working tools after the plowing has been done. With the modern low-headed orchard tree it will be impossible to plow close up to the trunks, and either the land will have to be plowed in strips only, or after the plow, may follow the wide-spreading harrows which will keep down the weeds and keep the soil under the branches light and loose if the work is done early in the spring while the land is soft. A low-hanging landslide plow with a long point and mold board will do much better work than the swivel or side-hill plow, though it may take more time to get about with it.

Many kinds of harrows have been tried, but those found most satisfactory are the acme or shears harrow, the wheel harrow and the spring-tooth harrow, all of which are arranged with the sections spread apart so that the horses will go outside the branches while the harrow will reach under them several feet, leaving but little hand hoeing to be done.

Two sections of the common spring-tooth harrow, attached to the evener with a chain about two feet long, will work well where the trees are not too close together, being drawn in under the branches by swinging the horses around each tree, leaving but little hand hoeing to be done. The California orchard harrow is largely used on the Pacific coast and would no doubt be of great value in other sections where there are large areas to cultivate. The grape hoe is found of great value in orchard cultivation, for being drawn by one horse it can be more easily guided than with a pair of horses. The common weeder is a great labor saver and if used frequently will keep the surface of the soil fine and mellow for about two inches in depth, but to give the best results, the spring-tooth or wheel harrow should be run once and then the weeder twice or three times. The weeders with straight teeth do better work in the orchard than those with curved teeth.

Some of these tools are perhaps too expensive for the small grower, and under such conditions two or more should join and purchase and use them together. Any of the above implements if properly housed when not in use and the wood parts kept painted should last a long time and do the work for many small growers.—(Mass. E. S. B. 82.)

Effect of Proper Cultivation.—(*a*) To give the plants one desires to grow all the light, air, and moisture that they can use by keeping out of their way all competitors in the shape of weeds. (*b*) The most common source of injury to our crops comes from drought. Soil that is compact will transmit water upward by capillary attraction much more readily than soil that is somewhat loose, and very loose dry soil loses scarcely any water in this way. This is the chief reason, and by many regarded as the only reason, for cultivation. The loose top soil acting as a mulch prevents the evaporation of water from the compact earth below. The extent of this protection is shown in the following table.

Soil depth.	Water in field.	
	With shallow surface cultivation.	Without shallow surface cultivation.
	Per cent.	*Per cent.*
3 to 9 inches	14.21	8.02
9 to 15 inches	17.21	12.38

(*c*) The working of soils opens them up so that the air can get in and assist in rendering available the plant food locked up in them in an insoluble form. This is an important function of tillage. The soil is a great laboratory in which many complex changes are continually taking place. Its continued cultivation sometimes affects it injuriously by oxidizing all the humus (decayed organic matter) and leaving it in a condition in which it washes badly and will not hold moisture. A good illustration of this change is in the fact that newly cleared land planted to orchard trees seldom wash badly until the decayed organic matter in it has become so thoroughly oxidized that it no longer holds the soil together. After this organic matter has disappeared, clay soils lose their loose porous texture and become hard and destitute of moisture.

Growing Trees in Sod.—This practice is not to be generally recommended, and yet there are sections where apples do exceedingly well when grown in sod or when mulched. In other sections, as on the high steep clay bluffs along the Mississippi River, trees may be grown to great perfection by spading up the soil about them for a distance of 3 or 4 feet from the trunk each spring, and later in the season the grass and weeds mowed and put around the trees. However, such locations are exceptional, and the great truth remains that orchards which are kept in sod are seldom profitable. When orchards are in a stiff sod, the rain water is often prevented from soaking into the land. An old sod on a steep hillside sheds water readily. The grass roots also take up large amounts of water from the soil. Therefore in sections liable to drought, the formation of a close sod in the orchard should be prevented as much as possible.—(U. S. E. S. B. 178.)

MULCHING.

Growing trees and other plants independently through the use of mulching may sometimes be successfully practiced under certain conditions. (*a*) Where there is an abundance of good mulching material. There is a great difference in the value of different kinds of mulch. A covering of coarse weeds, for instance, may afford but little protection. (*b*) Where the soil is well worked in the spring before the mulch is applied. (*c*) Mulch may often be used to advantage close to the trees where the soil near them is not easily cultivated. (*d*) Raspberries, blackberries, currants, and gooseberries may be grown by a system of mulching without cultivation, but it is seldom desirable to do so. (*e*) While cultivation of the soil is not as successful in the conservation of moisture as mulching, when mulching is done in the best manner, it is nevertheless far better than mulching as commonly practiced. (*f*) Mulching fruit plants the year round tends to encourage the development of surface roots which are liable to be injured by freezing. The roots also interfere with cultivation when the mulching is discontinued. (*g*) Mulching greatly increases the risk of damage in case of fire. (*h*) The mulch about plants furnishes a harbor for injurious insects, field mice, etc. These pests are most easily kept in check by clean cultivation.—(U. S. E. S. B. 178.)

The Sod Mulch.—The Hitchings or sod mulch system of orchard soil management has attracted considerable attention during the past few years, and has been the basis for considerable experimental work. The sod mulch system needs to be explained to many fruit growers and farmers who go into fruit growing, because they confuse cropping to hay with sod mulch. In the sod mulch system nothing is removed from the orchard. All grass is cut or left where it falls or is gathered and piled around the base of the trees. More recently it has come to include the hauling of additional litter and piling around the trees. Its advocates claim many advantages for it, while its opponents point out some evils. Undoubtedly the sod mulch system has some merits. As a means of conserving and controlling moisture, however, it is less satisfactory than the clean culture cover crop system, and in several other respects is inferior to the latter method of orchard soil management.

The sod mulch does have a place in apple growing in this state. On rolling sites where the slopes are so steep that washing of cultivated soils entails danger from serious soil washing, the sod mulch will be found the most successful method of meeting the situation. On other locations, however, the clean culture cover crop system is recommended as the writer believes the sod mulch system inferior to the latter.

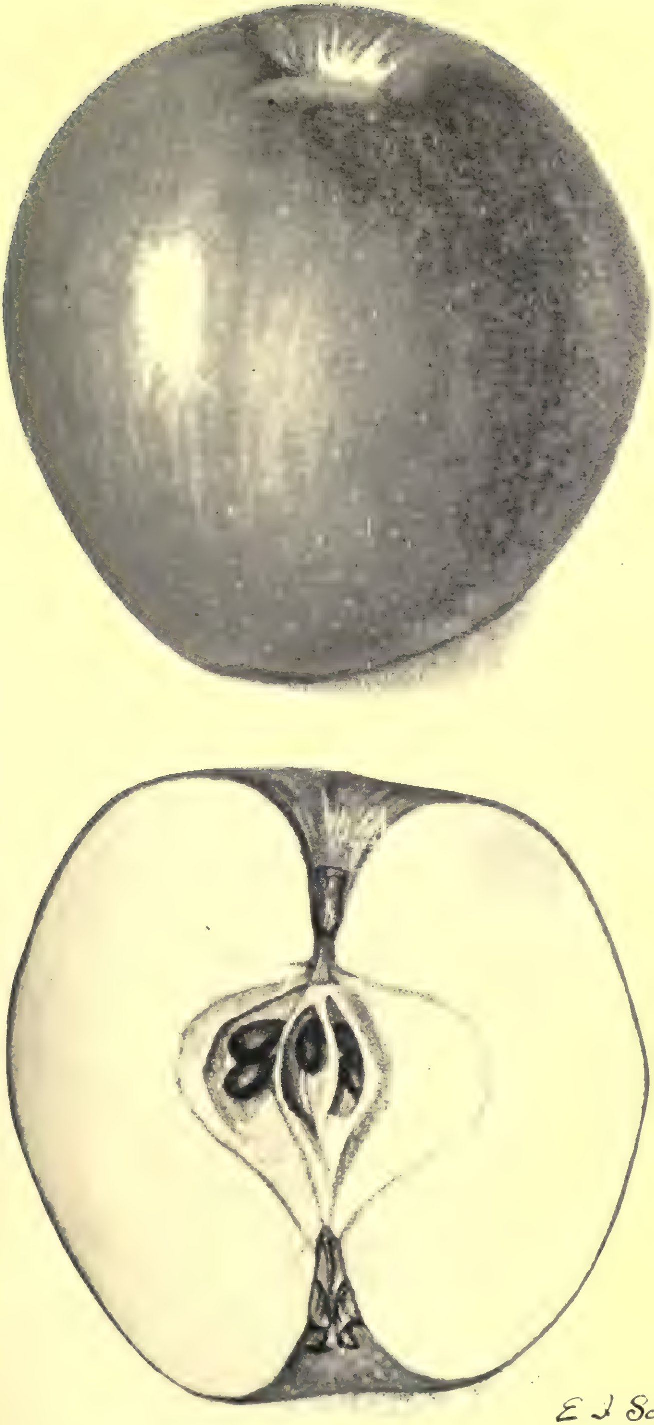
The Half Sod Mulch.—The half sod mulch is a combination of the sod mulch and the clean culture cover crop system. It is used by those who prefer cultivation to the sod mulch, but whose sites are too steep to permit of cultivating the entire area. A strip of sod four to six feet wide is left along the row, and running as nearly as possible at right angles to the direction of the flow of water. These sod areas are handled the same as in the sod mulch, while the space between is cultivated during the early part of the season and receives a cover crop later on. The advantages of the system are that it prevents washing and at the same time gives practically all the advantages of the clean culture cover crop system.—(Wis. E. S. B. 207.)

COVER CROPS.

As used in orcharding, the so-called cover crops are the crops grown in orchards for increasing the fertility of the soil and to conserve moisture. In general, the best fruit growers are a unit in advocating the importance of clean cultivation for orchards, but this sometimes results in reducing the soil to a condition which can only be fully remedied by the addition of humus. This, however, may be supplied by the application of coarse stable litter or decayed organic matter directly to the land. In this case the humus applied is confined almost entirely to the few upper inches of the soil. By growing clover or similar deep-rooted crops the decaying roots will leave humus in the subsoil and also render it porous. Other advantages of cover crops are (*a*) that they protect the soil to some extent from deep and sudden freezing and thawing; (*b*) they prevent the snow from blowing away in the winter; (*c*) such cover crops as clover and pease not only improve the physical condition of the soils on which they grow, but also makes them richer in nitrogen. On this account they are especially valuable for orchards.—(U. S. E. S. B. 178.)

The Clean-Culture-Cover-Crop System.—This system has come to be considered by a large majority of fruit growers as the best for orchard soil management. It consists in keeping the orchard under cultivation during the first part of the growing season, then sowing some crop which remains on the ground over winter.

The orchard is plowed in the spring to turn under the cover crop of the previous year. If the orchard has been under cultivation from the first, there will be no danger of injury to the roots. If, however, the orchard has been neglected or has been in sod for some time, the first plowing should be shallow, and the later ones slightly deeper each time until the desired depth is reached. The orchard does not need to be plowed as deep as though a field crop was to be grown upon it. As the base of the trees is approached, the plow should be run more shallow. It is usually more convenient to use only one horse in turning the last two or three furrows next to the tree. This permits getting much closer to the tree without so much



E. I. Schutt

Coffman Apple.

danger of injury. Using a short whiffle-tree either with leather ends or having the ends covered with burlap protects the trees from barking.

All the soil possible should be turned and that which cannot be reached with the plow conveniently, should be stirred with the cultivator later on. At times when the cover crop leaves but little vegetable matter on the soil in the spring, or when it is well decayed by time for beginning cultivation, the cut-away or disc harrow may be substituted for the plow. Plowing or discing is best followed by harrowing. The number of times the orchard should be harrowed depends somewhat upon local conditions. After putting the soil in good tilth following the plowing, the orchard should be harrowed at least every two weeks. The object to be attained in this cultivation is to keep a good dust mulch on the surface to conserve the moisture, and incidentally to keep down the weeds.

Harrowing should follow each rain as soon as the soil is sufficiently dry to work. Not only does this help conserve the moisture from the rain, but if the dust mulch which has been destroyed is not replaced, not only that which has recently fallen, but also additional amounts previously held in the soil will be speedily lost. Cultivation is valuable during periods of drought. Many growers believe that because no rain has fallen since the last cultivation, that it is a waste of time to harrow again. Repeated moisture determinations made during a period of drought of frequently cultivated and uncultivated soils but in all other respects similar show that the cultivated areas retained much more moisture than the uncultivated.

Cultivation of the orchard soil is not only valuable as a means of conserving moisture, but it hastens the availability of food materials in the soil and provides for good aeration, both of which are of so great importance. "Remember that cultivation is essentially manure." This quotation from the late Dr. Kedzie is indicative of the value of cultivation as a factor in the availability of plant food.

When to Sow Cover Crops.—The time at which cultivation shall cease and the cover crop be sown is very largely a matter of judgment. It depends almost entirely upon what soil moisture conditions are during the latter part of July, and what they are likely to be during the remainder of the season. One of the chief objects of the cover crop is to assist in controlling the moisture content of the soil during late summer and early fall. If there are large amounts of moisture in the soil during this period, there is danger of new wood development continuing so long that it goes into winter only partially matured, and is very likely to winter kill. On the other hand reducing the quantity of moisture in the soil tends to hasten maturity and avoid unfavorable conditions.

It will be seen then that in a season in which there is heavy rainfall or probability of heavy rainfall during August and September, that a rapidly growing cover crop becomes an effective means of reducing the moisture content of the soil. In seasons of drought, the cover crop will make proportionately less growth and not prove injurious to the trees. In wet seasons the cover crop should be sown comparatively early; in dry seasons, rather later sowing is best. As a usual thing it is sown between July 15 and August 1. In a season of drought during the early part of the season the probabilities of late growth are quite as great as when June and July have been rainy months. It is well, therefore, to have the seed in the ground ready to begin growth as soon as soil moisture conditions will permit.

Another important function of the cover crop is to add vegetable matter to the soil. Without the cover crop the orchard soil would soon become depleted of its vegetable matter which would destroy its tilth and make the plant food much less readily available, unless considerable quantities of barnyard manure are applied. An ideal cover crop then should produce considerable vegetable matter. In order to do this the importance of having it ready to begin growth following a drought in July or August is apparent. Rapid growing crops are usually preferable to slow growers, although at times for special purposes the slow growing crop may be more advantageous.

Cover Crops as Plant Food Suppliers.—Cover crops may be made to serve the purpose of increasing plant food in the soil. Not all crops used for covers are able to do this. Only leguminous crops such as clover, peas, and vetch are capable of adding plant food, and these only nitrogen. The leguminous cover crops, however, are a valuable asset in keeping up the fertility of the orchard. If used too continuously it may prove detrimental for excessive nitrogen tends to cause excessive wood growth at the expense of fruit production. It also favors late growth, and in this way may result in considerable winter top-killing. Because of these unfavorable conditions which are likely to arise, it is a good plan to practice rotation of cover crops using leguminous crops on average soils, not more than two out of three successive years.

Hardy and Non-Hardy Cover Crops.—In addition to being divided into food supplying and non-food supplying, cover crops are also classified as hardy and non-hardy or tender crops. The hardy crops live over winter and make some growth in the spring thus increasing the vegetable matter returned to the soil. They may or may not be efficient in holding the snow or preventing deep freezing. Hairy vetch, although a hardy crop, is usually less efficient in these respects than is oats, which is non-hardy, but which stands up well after frost.

In the food-supplying, hardy group of cover crops are hairy vetch and crimson clover, the latter of which can only be considered half hardy in Wisconsin. Of the tender food-suppliers, we have field peas and soy beans. Of the hardy non-food-supplying class, the most important is rye, but wheat is occasionally used. The increased cost of the seed, and the fact that the character of its growth is much the same as rye, makes the latter more in favor.

Of the non-food-supplying tender crops, oats, millet, turnips, and rutabagas are the most used. The two latter might be placed in a class by themselves due to the fact that they have tender tops which kill back with the frost, but roots which live over winter and produce growth the following season. It is not necessary that each crop be grown alone, frequently two or more are grown in combination. Probably the most used combination is that of oats and Canada field peas.

Some of the chief advantages and disadvantages of the various plants mentioned above, in their use as cover crops are: Hairy vetch is especially hardy; makes a rapid growth in spring; is slow to catch in a dry season; makes slow growth in fall; is low and does not hold snow as well as some of the other crops. Crimson clover can only be recommended in certain localities owing to the fact that it winter kills. Where it is hardy it makes a very good cover if a catch can be secured. Field peas are one of the best food-supplying crops; make a heavy growth; are especially valuable when mixed with some other crop which provides support. Soy beans are more tender than field peas, but stands up better after frost. Rye is the best non-food-supplying hardy cover; does not make as much growth as oats in the fall, but stands up somewhat better during the winter. Oats is probably the most used of all covers; comes quickly when sown, makes a good growth, stands up fairly well during the winter. Barley possesses about the same merit. Millet is similar to oats, but less hardy and does not stand up as well. Turnips and rutabagas add considerable vegetable matter, but lack the essential qualities necessary for holding snow; especially valuable for rendering available phosphoric acid.

Amount of Seed for Cover Crops.—The amount of seed to be sown for the various crops is practically the same as that in ordinary field culture. It is better to err on the side of having the cover too thick rather than too thin. There is little danger on the side of the former, save in the expense of seed, as the denser the growth, the better it stands up, and therefore the better it holds snow. The following amounts may be considered as indicating the quantity of seed to be used per acre: Hairy vetch, 1 bushel; crimson clover, 15 pounds; field peas, 2 bushels; soy beans, 3 to 4 pecks; rye, 1 to 1½ bushels; oats, 1½ to 2½ bushels; millet, 6 pecks; turnips and rutabagas, 4 pounds.

It is well to harrow the ground just before sowing, and to put in the crop exactly the same as for field conditions. Once in the ground, the crop needs no further attention until time for cultivation the next spring, when it is to be plowed under and the system of clean culture again taken up.

Occasionally an orchardist stops cultivating at the proper time, and allows nature to provide him with a cover crop in the form of weeds. It would hardly seem necessary to advance any argument against such a procedure. The growing of weeds as a cover crop simply means that the labor expended in eradicating them will in time more than offset the cost of using a legitimate cover. Some may say that the season of growth will be too short for the weeds to ripen seed. If this be true, it will only be a short time until those weeds which produce the cover are those which have a short season and ripen seeds early, for unless this be so, the weed cover crop must in a short time lose its source of seeding and become a thing of the past. At the very best, a cover crop of weeds is an uncertain thing.

How to Combine the Advantages of Cover Crops and Cultivation.—This is an important question for orchardists. In many fruit sections, this is done by the cultivation of the soil during the summer and seeding down to some cover crop in the late summer or early autumn. The crop may be one that will kill out in winter or one that will live over and be allowed to grow on the land until late spring, when it is turned under. Occasionally it is a good plan to seed an orchard down to clover for a year or two in order to increase the humus in the soil and thus prevent erosion, as for instance in the case of soils on steep hillsides where the humus has become almost exhausted. For this purpose the land should be plowed preferably in late autumn and the clover seed sown in late spring without any nurse crop.

Examples of Practical Use of Cover Crops in Various Fruit Districts.—(*a*) *Oats.*—Peach growers of Michigan and apple growers and nurserymen of Minnesota sow oats in their orchards about the middle of August to protect the roots of the trees against severe freezing and to prevent the leaves and snow from being blown off. (*b*) *Crimson clover* is an excellent cover crop for parts of New York State and south to Alabama. It should be sown in late summer or early autumn in New York not outside of Long Island. Crimson clover is only a summer crop over the larger part of the State, but in Alabama it grows all winter. (*c*) *Buckwheat* is a good cover crop for steep slopes or other places which it may be desirable to cover in summer. It should be sown in late spring. (*d*) *Vetches* may sometimes be used to advantage for a cover crop and should be sown in early spring. (*e*) Such perennial crops as *mammoth clover,* and even *alfalfa,* may be used as cover crops if plowed under the second year. They should be sown in orchards, without a nurse crop, in the early spring. The following table shows the number of pounds of seed required per acre to obtain a good stand of the cover crops commonly used in this country:

Nitrogen collectors:			Nitrogen consumers:		
Alfalfa	pounds	40	Rape	pounds	9
Hairy vetch	do	40	Turnip	do	2
Cowpeas	do	90	Rye	do	30
Soy beans	do	90	Oats	bushels	2
Velvet beans	do	25	Barley	do	1¾
Mammoth clover	do	20	Buckwheat	do	¾
Crimson clover	do	20	Corn	do	½
Sweet clover	do	15			

(U. S. E. S. B. 178.)

The question of cropping the orchard is an important one. As a rule, this should never be done, and yet it may often happen that while the trees are young and before they need all the space between them some other crop can be grown on the land to advantage.—(U. S. E. S. B. 178.)

The Orchard as a Pasture.—Pasturing the orchard is probably the most common method of solving the orchard soil question. While it is better than some of the other methods employed, so far as soil fertility is concerned, nevertheless it is a practice which should be discouraged. In the first place, it does not increase the fertility of the soil as commonly supposed, but rather robs it unless the animals pastured are receiving other feed than that secured from the grass. Unless animals are grain fed and full matured, the plant food materials removed usually exceed those returned to the soil through the manure.

Not only is the soil robbed, but very frequently the trees are seriously injured if not entirely ruined. There are apple trees six inches in diameter with the bark torn off by hogs which were pastured in the orchard. Horses and cows do damage by rubbing against the branches, breaking them, and knocking off the fruit as well as browsing on the trees.

The Orchard as a Hay or Grain Field.—The second most common use of the orchard is as a hay or grain field. This practice cannot be too severely criticised. It is nothing more nor less than an attempt to double crop an area with the result that neither is a success. It is practically impossible to grow a crop of marketable fruit in this state without spraying several times during the growing season, and this would be ruinous to the grain. As the result, no spraying is done and the fruit is wormy and scabby and often entirely unfit for the market. The trees also suffer for the crops demand the moisture and available food materials just when the crop is making the largest demands.

The crop is not a success, for the trees shade a considerable portion and take so much moisture that it fails to develop, resulting only in a partial crop. The cost of seeding and harvesting is greater than where there are no trees to interfere. This is not successful orcharding, or successful grain growing; it is soil robbery. Either give up the orchard or quit using it as a place to produce hay or grain. That some horticulturists recommend the sod-mulch is no argument for such a practice for this is not what is meant by a sod-mulch system.—(Wis. E. S. B. 207.)

Potatoes and corn require the cultivation of the soil in summer, and consequently are among the best to grow in an orchard. Preference should be given to those crops that do not require the cultivation of the soil late in autumn. If the orchard is to be cropped care should be taken that the fertility of the soil is not impaired thereby, and ordinarily it will be necessary to add manure to replace the plant food removed.

Small fruits of various kinds may be used in orchards but must be removed when the trees get large enough to need all the land.

Planting with fillers is the system of planting an extra number of trees on the land with the purpose of cutting them out when they get large enough to crowd those that are to remain permanently. Good examples of this practice are found in the planting of peaches or plums in the intervals between apples or the planting of twice as many peach or plum trees as can grow to maturity, the intention being to cut out one-half as soon as the trees begin to crowd. It is not a bad practice when faithfully carried out, but, in the hands of the average cultivator, the thinning process is seldom begun soon enough, which may result in serious injury and is always harmful.—(U. S. E. S. B. 178.)

The question of the portion of land which may be used in orchard cropping is one which is open to various opinions. It will depend first upon the distance between the trees, and second, upon the age of the orchard. In a newly planted orchard a strip three to four feet wide should be devoted entirely to the growth of the trees. As the size of the trees increase from year to year, this space should be gradually increased. At all times it would be advisable to give the trees all of the soil which the roots permeate, and use only that unoccupied by the trees for the crop which is to be removed. The mistake is too often made of growing other crops too close to the trees often resulting in permanent injury to the tree.—(Wis. E. S. B. 207.)

FERTILIZER REQUIREMENTS OF FRUIT CROPS.

Preparation is a very important process in planting out orchards and small fruits. Frequently fruit growers are in such a hurry to plant that they are obliged against their better judgment to set out trees on ground unfitted by tillage for their reception. Trees to do their best need to have the land in a high state of culture when they are planted. It is wise, where practicable, to anticipate planting by two or three years and practice a rotation of crops which will bring the soil into perfect condition. Deep plowing can not be done in the orchard, but is by all means to be advised in the years preceding planting. The turning under of green manures and the growing of hoed crops is advisable. On rich land or new land which needs subduing, corn is a very good crop to plant. It is the best index crop known for bringing out the inequalities of the land. It will show the poor spots that need extra manure and frequently will develop the wet areas which need drainage. Cotton also answers fairly well for this purpose in the South. The best thing, however, to immediately precede the planting is some crop like Irish potatoes, sweet potatoes, or garden vegetables of some kind. Such crops bring the soil into practically a garden condition, for with them deep plowing, high manuring and fertilizing, and thorough cultivation are commonly practiced.

Subsoiling is to be highly recommended on all lands which are underlaid by a more or less stiff clay subsoil. This should be done when necessary in the fall, immediately preceding the planting of the trees. Perhaps the best way is to subsoil the strip 6 to 8 feet wide on which the trees are to be planted. Then the following fall subsoil a strip 3 or 4 feet wide on each side of this strip, and continue this annually until the center is reached. Subsoiling is particularly important, for the reason that it opens up stiff clay subsoils to the passage of the roots and deeply stirs the land in a manner which can never be done after the roots occupy the soil. However, cowpeas and clover in the orchard can produce a somewhat similar effect. One of the features of intensive horticulture is to give the trees or plants good care at the start and then to keep it up continuously.—(Y. B. 1904.)

Agricultural Soils Have Two Forms of Plant Food.—(*a*) In new fruit-growing districts, where the land has not yet been cropped extensively, the soil is usually rich in plant food that is readily available for use. This is the soluble form. (*b*) Soils contain in addition plant food in forms not readily available to the roots of crops. Many soils consist almost wholly of this unavailable plant food. This is especially true of those that have been improperly farmed for long periods. This is the insoluble form of plant food.

Each year a portion of the insoluble plant food in the soil is rendered soluble, or at least is got into such condition that the roots of plants can use it. Where this process fails to supply an amount sufficient to produce a crop, and where there is no reserve of soluble food left from previous years upon which the plant may draw, this lack may be supplied by the addition of suitable fertilizers, either animal, vegetable, or mineral. In sections of this country longest cultivated lands of this character abound, and consequently the application of fertilizers is a necessary if a full crop is to be grown.

There are new soils already so rich in plant food that nothing is gained by manuring them. In fact, fruit trees on such soils are often injured by the use of too much fertilizer, which causes growth to continue until late in autumn. But such cases are comparatively rare. Practically all of our fruit lands, particularly those in the older fruit-growing sections, are greatly improved by the judicious application of manures.—(U. S. E. S. B. 178.)

Red Soils Oxidize Organic Matter Readily.—While red soils are known to be good fruit soils, it should be remembered that they oxidize or burn out their supply of humus or organic matter very rapidly. Because this organic matter is exposed to the air, just as it is in the sandy soil, and is therefore quickly oxidized, therefore manure applied to a red soil or a sandy soil will show greater results in the first year or two than on a tight, close clay, but the benefits will not be nearly so lasting. The same is true of a crop of green manure. Such types of soils as these therefore become deficient in humus much quicker than what we commonly term slower and tighter clay lands.

It is, furthermore, true in the case of the red soils that in the change from a moist to a dry condition of the soil there are important chemical changes in the iron itself which greatly facilitate the burning out of the organic matter. This is due to the fact that the red oxide of iron in contact with organic matter and in the presence of moisture is reduced to a sub-oxide, giving off by this process a portion of its oxygen to burn the organic matter present in the soil. In the drying of the soil, the sub-oxide of iron is quickly raised to the higher form of the red oxide, ready to give up again in the presence of moisture its oxygen to burn out the vegetable matter. This process of oxidizing organic matter continues as the land alternates between wet and dry conditions. It is of the utmost importance, therefore, that the owners of red land should be especially careful to maintain a liberal supply of humus under all circumstances, and to calculate upon this extra loss due to the presence of the iron.—(Mo. E. S. Cir. 22.)

Making the Plant Food in the Soil Available.—As is well known, only a small portion of the plant food contained in any good soil is at any one time available to growing crops. The processes which render this plant food available are going on more or less actively, practically all the time. The rate, however, at which this food is made available to the growing tree will vary according to the season and to the method of treating the soil. For example, during an excessive wet season, when the soil is either water-logged or being leached much of the time, there is unlocked in the soil a relatively small amount of plant food, and much of that which was already made available is lost either temporarily or permanently through the processes of leaching. This means that the soil should be watched carefully the year following an excessively wet season. This is particularly true if the trees following such a season happen to set a large crop of fruit. Then, during a very wet season, the soil solutions are so diluted that the trees will actually find less plant food and have greater difficulty in getting that which they do find.

Likewise, in a very dry season the chemical and biological changes are very much retarded, owing to the absence of moisture. Nevertheless, it should be remembered that in such a season the movement of soil moisture is upward from great depths, and large quantities of moisture are brought to the surface and vaporized. The plant food that had in wet seasons been carried beyond the depths of the ordinary growing crop is brought by this upward movement of the water to the surface and by the vaporization of the water deposited there in a readily soluble form. This does not mean, however, that the plants derive benefit from these salts during tne drouth, for there is not sufficient moisture in the soil to make this possible. Therefore, while a dry season does not favor the breaking down of the plant food compounds in the surface soil, it does in fact favor the accumulation of this soluble plant food in the surface soil, by bringing it from great depths, and also by the limited amounts used by the trees on account of the small fruit crop and the very sparse growth they make in such an unfavorable season.

Thus should there be expected following a very dry season an extraordinary season of growth, and if by any treatment in that dry season we can without permanent injury to the trees induce them to set a good fruit crop the following year, it is very likely to prove exceedingly favorable for the development of this fruit. Not only are the conditions likely to be favorable for the development of a fine crop of fruit following a dry year, from the standpoint of an abundance of plant food to mature a maximum crop, but from the standpoint of a diminution of insect pests and a reduction of the prevalence of fungous diseases.

In the ordinary season it is necessary for orchardists to put forth some effort in order to unlock the plant food contained in this soil.

The conditions most favorable for the unlocking of this food and rendering it available are the presence of air, carrying as it does free oxygen, and carrying also carbonic acid gas, which is indirectly a very powerful solvent. Thus the systematic aeration of the soil favors its breaking down and increases the ratio of available plant food This aeration may be accomplished in two important ways: One, by systematic tillage, another by keeping up the supply of vegetable matter. Humus or vegetable matter keeps the soil open and porous, so that the air may circulate freely, and in addition, through the decaying of organic matter, liberates a large quantity of carbonic acid gas, which it is just learned is effective in unlocking plant food. Humus also assists in maintaining a more uniform water content in the soil, preventing it from becoming water-logged for long periods after a rain and preventing it from drying out to that point where very little or no chemical changes occur.

In soils deficient in humus this dry condition occurs as a rule in midsummer, when the temperature and other conditions are naturally most favorable to the breaking down of the soil, and at the same time when the trees are carrying the maximum of fruit and when they stand in greatest need of a copious supply of moisture and plant food. And even if the trees are not carrying fruit, they need food at this time of the year to mature the growth they have started in the spring and to fill out and perfect the fruit buds they have formed, in order that both wood and buds may be in good condition for the succeeding winter.—(Mo. E. S. Cir. 22.)

Manuring the Orchard.—In manuring the orchard one object is to get a maximum crop. The crop that is up to or possibly just below the average is seldom a profitable one. It is generally inferior in quality as well as lacking in quantity. Its defective character lowers it to such extent that it is brought in competition with the crops of all the poorest cultivators and must be sold often in a glutted market and usually to those who have small means with which to buy.—(U. S. E. S. B. 178.)

In the case of such disastrous drouths as in 1901, it is always the neglected and underfed orchard that suffers most. It is likewise true that underfed trees fall a victim to the attacks of borers, aphis, root rot, etc., much more readily than those that are well nourished. As in the animal kingdom, it is the starved animal that carries all the parasites known to the kingdom, whereas, sleek, fat, well fed animals escape their ravages. When an unfavorable season finds an orchard well set with fruit the fact as to whether it has been well cultivated and is well nourished or not, in other words, as to whether there is present a reasonable supply of available plant food in the soil, exerts a profound influence upon the effect of this unfavorable season upon the crop and upon the life and vitality of the trees.—(Mo. E. S. Cir. 22.)

The elements that enter into the composition of fruit crops are the same as those of farm crops. Although they differ somewhat in their relative proportions one need not be particular, in fertilizing an orchard, to compound the manures exactly according to these proportions. Our knowledge of soil conditions is as yet too incomplete to enable us to know the precise amount of each fertilizing ingredient to apply in order to exactly supplement the available fertility in the soil. Each grower must study his own soil conditions and test the effects of different manures on it in order to get the best results.

The chemical elements that compose our fruit and agricultural crops are oxygen, hydrogen, nitrogen, phosphorus, sulphur, iron, potassium, sodium, calcium, magnesium, chlorin, and silicon. Nitrogen, potassium, and phosphorus are the elements commonly lacking in the soil and it is these that we look for in fertilizers. These elements each act differently in affecting vegetation. To be used by plants, they must be soluble. Soil that has large amounts of soluble nitrogen in it produces a vigorous soft growth of wood and a dark green color in the leaves. On such land trees are liable to grow late in autumn and to winterkill. The fruit is likely to be low colored and of poor keeping quality. For peaches such soil is more injurious than for apples or other hardy crops. Nitrogen encourages a growth of wood rather than fruit. Large amounts of potash and phosphoric acid in the soil cause a firm, solid growth of wood, early maturity of plant, and firm, bright colored, long keeping fruit. Nitrogenous fertilizers in sufficient quantity can usually be supplied by the use of barnyard manure or by plowing under leguminous catch crops. Of the commercial forms nitrate of soda, sulphate of ammonia, dried blood, and tankage are most common. Potash fertilizers seldom need be applied heavily on well-tilled clay soils, as such are usually well supplied with potash. Wood ashes afford potash in a readily available form. Unleached hardwood ashes are most useful. The leading commercial forms of potash are the sulphate and muriate and a lower grade product known as kainit. Phosphoric acid is more often lacking in the soil than potash. It is supplied by applications of ground bone, finely ground rock phosphate, either raw or after treatment with sulphuric acid, which renders the phosphoric acid much more readily available to plants. Treated ground bone or ground rock is known as acid phosphate or superphosphate.

To secure the best results each of the elements—nitrogen, phosphoric acid, and potash—must be available to the plant in the proper proportions. These elements are all necessary for healthy plant growth. The following table shows the amount of plant food, nitrogen, potash, and phosphoric acid taken from the land by a crop of 75 barrels of apples. This amount is here used, as it represents a good average crop of apples per acre:

Water.	Dry matter.	Nitrogen.	Phosphoric acid.	Potash.
9,563 lbs., or 85 p. ct.	1,687 lbs. or 15 p. ct.	4.5 lbs., or 0.04 p ct.	2.25 lbs., or 0.02 p. ct.	11.25 lbs., or 0.1 p. ct.

To raise this crop of apples there must be about 50 trees, each one of which is fifteen years old. The branches, trunk, and roots of such a tree will weigh about 1,400 pounds, of which 40 per cent is water. It is probably fair to assume that the weight of the new growth of wood of a thrifty apple tree at fifteen years of age is 50 pounds per year, from which the amount of plant food used for the wood each year can be readily computed. It is also safe to assume that the amount of plant food yearly set free in the soil is sufficient to take care of this growth of wood. The leaves are returned to the soil and hence the manurial material in them does not have to be supplied to the soil. If therefore enough plant food is supplied to replace the manurial ingredients that were taken away from the land in the crop harvested, the land will be maintained in good condition. There is nothing very exact about the amount of manurial material removed each year as it will vary with the soil, the variety of crop, and other conditions.

The following table shows approximately the amount of plant food materials removed in one year from the soil of an acre of land fully stocked with thrifty fruit trees of the kinds named. This includes the amount contained in the new wood, foliage, and fruit:

Kind of fruit.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesium.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Apple	51.5	14	55	57	23
Peach	74.5	18	72	114	35
Pear	29.5	7	33	38	11
Plum	29.5	8.5	38	41	13

The following table shows the amount of nitrogen, phosphoric acid, and potash found in a good crop of fruit grown on 1 acre:

Kind of fruit.	Fruit.	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Apples	11,250	4.5	2	11.25
Pears	10,000	4	1	12
Plums	7,200	7	3.6	14.4
Peaches	4,950	4	2	9
Quinces	7,200	8	3.6	17.2
Raspberries	4,800	5.6	4.3	12
Blackberries	4,800	9.6	2.4	11
Strawberries	4,000	5.2	2	9.2
Currants	4,000	12	4.8	12
Gooseberries	4,000	6	2.8	.8
Grapes	6,000	9	4.2	18

This nutrition may be supplied in many forms. Maynard gives the following formulæ: (*a*) For fruit trees over ten years of age (40 trees) varying in quantity according to the condition of the soil and crop, 250 to 500 pounds of fine-ground bone; 100 to 300 pounds of sulphate of potash; 50 to 150 pounds of nitrate of soda. (*b*) Hardwood ashes at the rate of 2 tons per acre and the same amount of fine ground bone. (*c*) South Carolina rock, 400 to 600 pounds, ground fine; 100 to 300 pounds of sulphate of potash; 100 to 300 pounds of nitrate of soda. (*d*) Barnyard manure, 6 tons per acre.—(U. S. E. S. B. 178.)

Difference in Availability for Different Kinds of Fruit.—This does not mean, however, that one fertilizer would be as well adapted to one fruit as to another. That is to say, there are qualities in a commercial fertilizer outside of the chemical composition which affect very materially its value and adaptability to particular uses. Chief among these qualities is the ease with which the elements of plant food contained therein are available. Under some conditions a very readily available plant food is required; under others, one that acts more slowly is much to be preferred. For example, it would perhaps be dangerous to use very much of a very quick acting fertilizer, especially if it contained very much nitrogen, on pears, for it is quite likely to leave the tissue in such a condition as to fall easy prey to blight. Likewise, it is as a rule not advisable to apply large quantities of a readily available plant food to apples. On the other hand, a peach orchard, located on comparatively thin land, and loaded with fruit, would be greatly benefited by a liberal quantity of a very readily available food. The same would be true of all the small fruits.

A safe rule in all cases would be in making up a commercial fertilizer to supply a small quantity of immediately available material and furnish the remainder in a slow acting form, so that a uniform supply of food may be provided and a steady and uniform growth promoted. This is more particularly true of nitrogen than of the mineral elements. To secure this condition with nitrogen the readily available material may be supplied in the form of nitrate of soda, or preferably dried blood, or cottonseed meal, and for the slow acting material, barnyard manure, tankage or a pure raw bone meal, or cheaper than any of these, cowpeas or clover. In the case of the phosphorus, a small quantity of acidulated rock would furnish the material required for immediate use, and the remainder could be more advantageously supplied in steamed bone, or much cheaper and probably quite as well in the long run, in finely ground raw phosphate rock. In this case it will always be necessary to plow under vegetable matter frequently to facilitate the unlocking of this phosphorus.

Dangers That May Follow the Use of Fertilizers.—If care and judgment be exercised in the amount of nitrogen applied and the season of the year in which the application is made, whether it be commercial fertilizer, barnyard manure, or a leguminous crop turned under, there will be no unfortunate results to follow. The only disadvantage in applying too much potash and phosphoric acid comes from the expense of buying an unnecessarily large amount of these ingredients. They will not cause too much wood growth, as will an excessive amount of nitrogen, and will not, so far as we know, diminish the tendency toward fruitfulness, or cause a late growth, or prevent a proper ripening of the wood for winter, or produce a soft and immature tissue that is especially subject to the attacks of fungous diseases. In truth, they and lime have just the opposite tendency.

Special care, then, need only be exercised in the application of nitrogen. The wood and leaf growth, as has already been pointed out, will show whether sufficient nitrogen is being supplied or not, and any excessive growth of leaf or twig will be conclusive evidence that too large a quantity has been used. Such a mistake in a young orchard may be readily remedied by planting to corn and removing both the corn and fodder, and in the case of large trees that seem to have been overfed with nitrogen, seed to timothy, removing as hay the crops, and by one or the other of these means the danger is quickly removed. The utmost care, however, should be taken not to carry this depleting process too far. It is like bleeding a patient for some malady—a most excellent thing to do when the patient really requires to be bled, but not a good thing if the bleeding process is carried too far.

This cropping under all circumstances is a great temptation, as it is reducing the expenses of handling and giving an additional return from the land, but if carried to the extent of depleting the soil and no effort be made to restore the fertility thus removed, the small return obtained from the farm crop will be much more than lost in the reduced vigor of the orchard and the diminishing crops of fruit. As has already been pointed out, it is especially bad policy to have the land alternately rich and poor. Better trees and better fruit will be obtained by a consistent policy of one side of the proposition or the other, and rather a somewhat underfed tree, existing under uniform conditions, than one that is this year underfed and next year overfed, or that is alternately rich and poor.

Application of Commercial Fertilizers.—On mature bearing orchards that are occupying the entire ground, it is quite as well to make the application broadcast and in the spring, immediately before the first cultivation, letting the tillage given mix the fertilizer with the soil. In the case of barnyard manure, it is possible and advisable to make the application in the autumn, after the ground is firm, say, from the first of November on, unless the land be very steep so that there will be serious loss from surface washing. The material would then be incorporated with the soil by the early cultivation, just as in the case of the commercial fertilizer.—(Mo. E. S. Cir. 22.)

HUMUS.

While always nitrogen, potash, and phosphorus are the elements most needed in the soil, a compound known commonly as humus, although not in itself a plant food, is so useful in improving the physical condition of the soil that it should be mentioned among the fertilizers. This material is the result of the decay of vegetable matter. It is nearly analogous to charcoal in its qualities of absorbing and holding gases and moisture. In the soil humus prevents washing and keeps it open and porous, and by its own decay sets free acids and perhaps other compounds that assist in making available plant food in the soil. It is the presence of this material in stable manure that probably largely accounts for its superior action as a fertilizer in the soil. Humus can be supplied to the soil most cheaply by means of cover crops, an important part of their value consisting in the furnishing of this material. The value of humus is well illustrated by experiments at the Minnesota Experiment Station, where corn grown continuously for six years on the same field yielded an average of 21.4 bushels per acre, while corn in a three-year rotation, including wheat and clover, yielded 47.1 bushels per acre. As the plat producing corn continuously has sufficient plant food to mature a normal crop annually, the low yield can only be accounted for by the poor physical condition of the soil produced through the depletion of the humus by frequent cultivation.—(U. S. E. S. B. 178.)

Thus does humus play a very important part: (1) In keeping the soil from washing; (2) in keeping it from becoming too dry in midsummer; (3) in keeping it cool in the heat of the summer; (4) in draining it in a manner; (5) in assisting in unlocking mineral plant food; (6) in holding in an available form and in preventing loss by leaching of mineral constituents; (7) in adding nitrogen; (8) in making the soil warmer in spring; (9) in making the soil more friable and loamy, and therefore cheaper and easier to handle. As to the best methods of getting this humus in orchard soil, circumstances must govern in all cases.—(Mo. E. S. Cir. 22.)

Qualities Desirable in a Green-Manure Crop.—No one plant possesses all the desirable qualities of an ideal green-manure crop. However, in the various crops used for such purposes, practically all the desirable qualities are represented, though varying in degree. The conditions under which a green manure is to be grown determine to some extent whether a certain quality is desirable or objectionable and must be taken into consideration in selecting the best crop to grow.

A green-manure crop should be a legume wherever possible, in order to obtain the addition of nitrogen to the soil. It is also necessary that a good growth be made, in order to have a large quantity of organic matter to turn under and incorporate with the soil. Along with good growth should be a heavy development of nodules on the roots, as this is believed to indicate great ability to fix atmospheric nitrogen.

The quality of being able to stand trampling with a minimum of injury is very important where the crop will be subject to such injury, as is the case in citrus orchards where the picking of fruit takes place while the green-manure crop is yet growing. Uprightness and nontwining stems are also desirable where an ordinary moldboard plow is depended upon for turning under the crop. However, if a disk plow is used or the crop is worked in with an ordinary disk harrow, this does not make so much difference, and where the growth is not allowed to become too rank little difficulty is experienced in plowing it under.

The texture of the stem should be such as to decompose readily. Practically all crops, however, if turned under at the right stage of growth decay readily. Thus, the question of decomposition is one of turning under the crop at the right time rather than one of selecting a crop that will decay readily.

That the cost of a green manure may not be too great, it is necessary that the price of seed be reasonable as compared with the results to be obtained.—(B. P. I. B. 190.)

Conditions Under Which Green-Manure Crops Should Not Be Used.—There are some sections in which green-manure crops can be grown satisfactorily, but their utility nevertheless seems questionable. This is especially true in lemon orchards having a very heavy soil, and to a less degree in orange orchards. By a heavy soil is not meant a heavy loam, but an adobe or a soil approaching that texture. On such soils the discontinuance of cultivation which is necessitated by the growing of a green-manure crop allows the soil to become quite hard and packed, thus permitting very imperfect aeration. This is a most undesirable soil condition to maintain during a period of several months, and its injurious effects may be seen in the unthrifty appearance of the trees. Where this effect is very marked it is undoubtedly best not to use a green manure, but to use stable manure instead, if such is available.—(B. P. I. B. 190.)

Varieties, Planting, and Pruning.—The varieties of fruit best adapted to a given location can not be named without special and careful study. Some that are very profitable in one locality, in another close by, with perhaps a different soil or elevation, may be complete failures. The selection of varieties for profitable culture is one of the most important matters that the fruit grower has to consider. There are many new varieties of fruit introduced each year and few of them are any better than old standard sorts, while the greater part are almost worthless.

The several varieties of fruits in cultivation may each be divided into two general classes: (*a*) Varieties of great vigor and productiveness, adapted to a wide range of country. These, as a rule, are somewhat inferior in quality but of fine appearance and good enough in quality to satisfy the average market. Among such varieties are the Duchess of Oldenburg, Talman Sweet, and Ben Davis apples; Bartlett and Anjou pears; Lombard and Quackenboss plums; Crawford and Elberta peaches; Concord and Niagara grapes; King and Cuthbert raspberries; Snyder blackberry; and Splendid and Warfield strawberries. These varieties do well over a large extent of country. They may not bring the highest prices, but sell well and are the popular standards. (*b*) Another class includes varieties that are sensitive as to soil and location and are not generally successful. Where they do well their fruit is of very superior quality. As belonging to this class may be mentioned the Newtown Pippin, Gravenstein, and Williams apples; Green Gage plum; Bosc pear; Columbia peach; Iona grape; Herstine raspberry; Lawton blackberry; and Jucunda strawberry.

In selecting varieties the fruit grower should choose such as are adapted to his market, for this is where their commercial value will finally be tested. Grow what the consumer desires. You want a fruit that will sell. The grower can not expect to change very materially the prevailing tastes of people. There is, however, a constantly increasing number of people who are becoming more particular as to the quality of fruit they use and are willing to pay a fair price to secure the best. The orchardist should not undertake to grow white strawberries, white raspberries, or white currants, for the markets, as a rule, demand that these fruits be red in color and that blackberries shall be black and not white. It is not worth while to attempt to change prevailing opinions in such matters for the sake of pushing some new variety, no matter how good its quality. Consumers generally want large size, bright warm colors, and at least fair quality in fruits.

The fruit grower should not select varieties because they are doing well elsewhere, but should become familiar with the experience of successful fruit growers in his section, and also get in touch with the experiment station men of his State and advise with them in these matters. He should study carefully the reports of his State and local horticultural societies, both of which ought to be very helpful. Varieties should be selected that will pollenize well together. There are some varieties of fruits that are self-sterile and which will not be productive unless near other similar kinds that will furnish suitable pollen. The following partial lists show varieties that are both self-sterile and self-fertile.

Fruit.	Self-sterile.	Self-fertile.
Plums	Miner	Robinson.
	Wild Goose	De Sota.
	Mariana	Rollingstone.
	Itaska	Forest Garden.
		Cheney.
		New Ulm.
Grapes	Brighton	Concord.
	Wilder	Niagara.
		Agawam.
		Delaware.
Apples	Winesap	Ben Davis.
	Gravenstein	Duchess of Oldenburg.
	Northern Spy	Baldwin.
		Red Astrakan.
Pears	Bartlett	Flemish Beauty.
	Anjou	Clairgeau.
	Nelis	Kieffer.

—(U. S. E. S. B. 178.)

List of Fruits.—In response to numerous inquiries the Ohio Agricultural Experiment Station in September, 1911, issued the following list of fruits which were considered dependable for that region, and for regions where the conditions were the same. The varieties are named in the order of ripening, or very nearly so.

APPLES.

Yellow Transparent—A Russian variety that has fufilled its early promise to supersede the Early Harvest. Very early, attractive in appearance, prolific, persistent in bearing annual crops. May

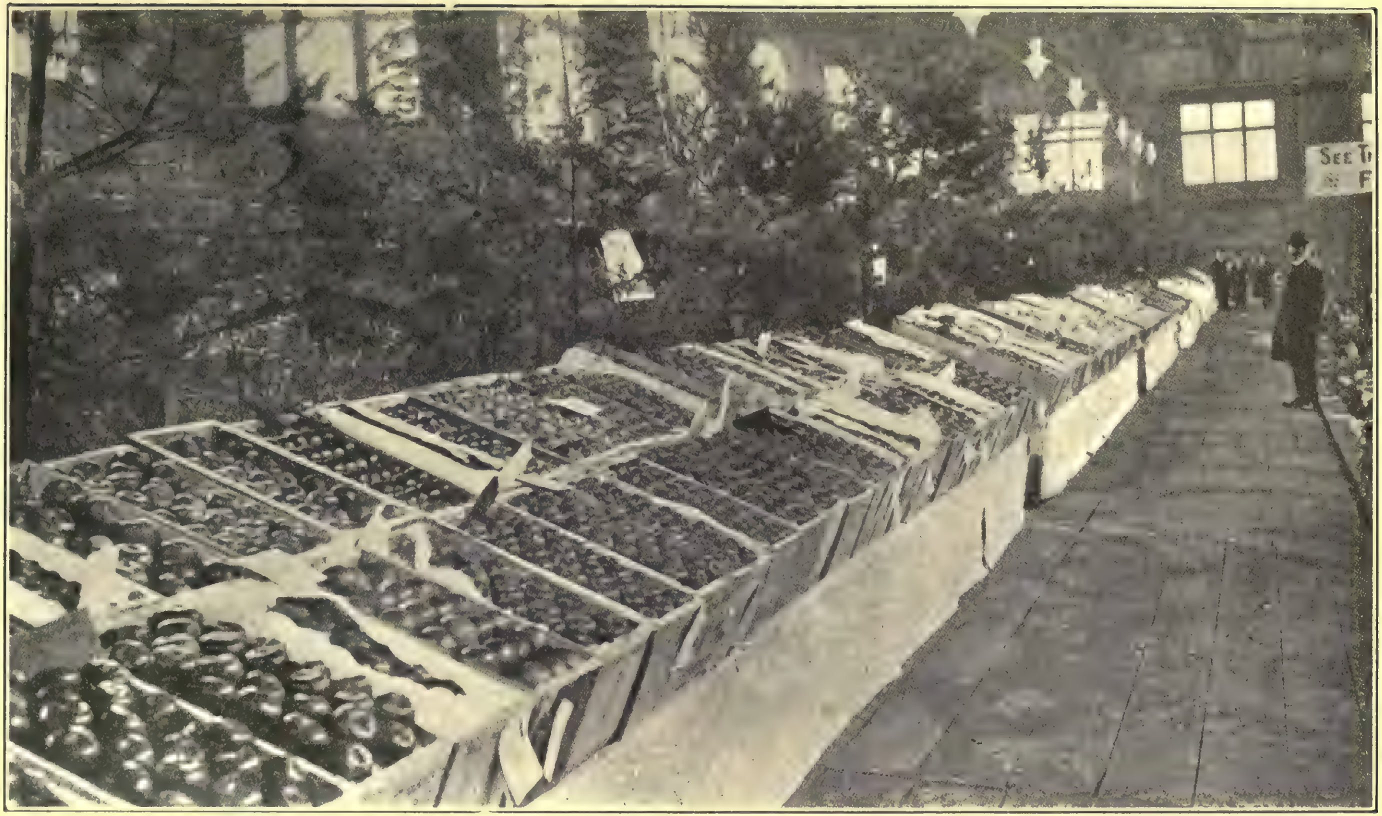


Exhibit of Boxed Apples at Ontario Horticultural Exhibition, 1909, Single Box Competition.

be used as a filler. Red Astrachan—A valuable early sort for home use and market. Slow in coming into bearing. Oldenburg (Duchess of Oldenburg)—A valuable summer variety suited to all sections. Beautifully striped, red over a greenish yellow ground. Quite acid; better for culinary use than for dessert. Useful as a filler. Sweet Bough—The best early sweet apple for all sections. Benoni—A late summer variety of excellent quality. A fine little dessert apple. Too small and too nearly sweet for a successful market and culinary variety. Munson's Sweet—A choice autumn sweet sort and reliable bearer. Maiden Blush—A valuable fall variety in all sections, for home use or market. Is subject to the apple scab and is greatly benefited by applications of fungicides. Wealthy—Bears young and abundantly. Good for culinary purposes. A fall variety in northern Ohio. Keeps well in cold storage. Huntsman—Not so well known as it should be. Yellow with dull red blush. Rich, spicy and excellent in quality. Late fall and early winter. Grimes' Golden—A valuable early winter variety for market or home use in all parts of the state, although it becomes a fall apple in the extreme southern portion. Its chief merit is high quality. Not subject to apple scab, but is liable to be damaged by late spraying with Bordeaux mixture. Delicious—Not fully tested in this state but seems to be worthy of trial, both for home use and market. R. I. Greening—Excellent for early winter use in Northern Ohio. Jonathan—A choice winter variety for home use, also for market. Tree a slender grower, but attains vigor with age, on good soil. An excellent and deservedly popular variety. Begins to bear at an early age. Bailey's Sweet—A choice winter dessert variety. Sometimes affected by bitter rot in the central and southern parts of the state. Northern Spy—A fall apple in most parts of the state, but in a few localities in Northern Ohio is a profitable winter variety. Very subject to apple scab and the apple worm, hence is greatly benefited by spraying. Highly colored and of good quality. Baldwin—One of the best winter varieties for the northern part of the state, but is a fall apple in the southern counties. Very prolific; bears every other year; not seriously affected by apple scab. York Imperial—A good market, winter variety for central and southern Ohio. An excellent keeper in ordinary cellar storage, but often scalds badly in cold storage. Rome Beauty—The best winter, market variety for southern Ohio, and does well in the central part of the state. It is greatly benefited by application of Bordeaux mixture. Gano—Much like Ben Davis in quality, but more highly colored. Preferable to Ben Davis, where it is desired to use either. Begins to bear when very young. White Pippin—A good keeper and excellent for culinary purposes. Slow to come into fruiting. Stark—A little dull in color but one of our most dependable winter sorts. Good quality and keeps well in cellar or cold storage. Stayman Winesap—Promises to be an excellent late keeping apple for central and southern Ohio. Good quality. Tree strong and vigorous in growth. It does not always color well in the northern part of the state.

PEARS.

Wilder—A good early variety of fair quality. Bartlett—The best known and popular summer variety for home use or market. Tree quite subject to blight, and the foliage often drops prematurely. Is benefitted by spraying with Bordeaux mixture. Angouleme (Duchess d'Angouleme)—A reliable and profitable fall variety; prolific; bears young; does well on quince. Anjou (Beurre d'Anjou)—Not excelled by any other late fall variety for market or home use. Succeeds either as a dwarf or standard. Seckel—Esteemed chiefly because of its high quality. Comparatively exempt from blight. Flemish Beauty—A choice autumn sort, but must be sprayed with Bordeaux mixture to prevent leaf dropping and cracking of the fruit. Quite subject to blight. Kieffer—A prolific and early bearer and seldom blights. Not of high quality, but is suitable for canning. Blooms early and is often killed by spring frosts. Season, October 15th to November 1st. Lawrence—A reliable winter variety, prolific and comparatively free from disease.

PLUMS.

Japanese Plums—This class of plums, of which such varieties as Abundance, and Burbank are representative, are not worthy of space in Ohio orchards and their planting can lead only to disappointment. The blossoms are liable to be killed by frost and the fruit is very subject to rot. Native Plums—There are scores of varieties of natives now known and offered by nurserymen. There are few varieties, however, worthy the space they would occupy on Ohio soils where the finer European varieties cannot be grown. The following varieties are most excellent dessert fruits, and a tree or two of each should be planted in every home collection: Wilder—Dark, dull red covered with yellowish dots. Skin thick, flesh yellow, juicy, rich, sweet and delicious. Hunt—large, dark red, sprinkled over with numerous small light dots and covered with a light blue bloom. Flesh pale yellow, firm, tender, melting, good. Downing—Large, crimson; skin thin and tender; quality good. Stodard—Large and of good quality. European Plums—May be quite successfully grown in all parts of Ohio. The best of all for culinary use. The following are choice varieties: Bradshaw—Very large, violet in color, excellent in quality. Tree slow to come into bearing. The same as Niagara. Field—A large blue plum as early as Bradshaw and equally as good in quality. Moore's Arctic—Very hardy and reliable. Less inclined to rot than most others. Lombard—Probably planted more extensively than any other variety, and has been found to be reliable in all sections of the state. The fruit must be thinned or the trees will overbear. Not as much inclined to rot as some, but by no means exempt. Imperial Gage—A light green plum of excellent quality. Better for home than for market, as its color is against it as a commercial fruit. Monarch—A large, round, blue medium late free-stone of excellent quality. Arch Duke—A fine late variety. Large, blue, firm, attractive free-stone. Tree vigorous and prolific. The best of all large, late plums. Quite free from rot. Grand Duke—A little later than Archduke. Not so good in quality.

Pit clings. Large, firm, handsome, free from rot. Tree a slow grower. Should be top-worked upon some vigorous growing sort. The Damson Class—Shropshire, French and Farleigh are the popular varieties of the Damsons, and should be more largely planted. Subject to black knot but quite free from rot.

PEACHES.

Greensboro—The first reliable variety to ripen. White flesh, freestone. Mountain Rose.—A reliable second early variety; suitable for home use or market; comparatively hardy; inclined to overbear. Carman—Large, white with blush. Vigorous grower; comparatively hardy in tree and buds. Cling. Belle of Georgia—Large, white, red cheek; flesh white, juicy, excellent; pit free. Champion—Flesh white, quality excellent, hardy in bud. One of the best for home use. Old Mixon Free—Recognized as a standard variety in all parts of the state. Flesh white and of good quality. Crosby—A reliable variety for home use, but too small for market, unless severely thinned. Yellow and of good quality. Fitzgerald—Is a fine, hardy, yellow variety. Elberta—Comparatively new, but quite generally found to be reliable, wherever tested; one of the best for shipping. Probably the most popular peach in all sections, at the present time. Smock—A very popular variety in all parts of the state. Salway—A profitable late sort along the lake, and in southern Ohio, but does not always ripen in other parts of the state.

CHERRIES—SOUR.

Early Richmond—Medium size, light red in color, quality good. A hardy, prolific, dependable, early variety; widely known and deservedly popular. Louis Philippe—Above medium size, dark red or nearly black when mature. Flesh red, tender, sprightly, subacid, good. Slow in coming into bearing. Reine Hortense—One of the duke class. Very large, roundish, slightly elongated; color bright red with mottlings of darker shades. Flesh tender, juicy, nearly sweet, of highest quality. Large Montmorency—One of the best of its class for home use and market. Large, red. Flesh tender, mild and of good quality. English Morello—Nearly black when ripe. Flesh red, acid but good. A standard and excellent late variety.

CHERRIES—SWEET.

Cherries of this class are not generally successfully grown in Ohio, and planting on a commercial scale can hardly be recommended. However, it is always desirable to include a few trees of the most dependable varieties in home collections. The following sorts are good: Ida—Very large, pale yellow with red blush. Flesh firm, sweet, tender; quality good. Remarkably free from rot. Gov. Wood—Similar in fruit to above, though smaller and more inclined to rot. Black Tartarian—Very large, of good quality. Popular as a home fruit wherever it can be grown. Windsor—One of the most reliable of the sweet sorts. Hardy and not inclined to rot.

GRAPES.

Moore's Early—The earliest good black grape. Good for home use and nearby market. Skin is tender and cracks badly when overripe, rendering it unfit for distant shipment. Green Mountain—One of the best early white grapes for home use, because of its excellent quality. Vigorous in growth, fairly prolific and comparatively free from disease. Delaware—Esteemed for table use because of good quality, also valuable for market. Rather weak in growth and subject to rot. Brighton—A choice red sort for home use. Worden—Earlier than the Concord, otherwise much the same. Diamond—A medium early white grape of excellent quality. Gaertner—Larger and lighter red in color than Brighton. Vigorous, prolific, good in quality. Concord—The best general purpose grape known. Niagara—A vigorous and prolific variety; somewhat subject to rot, but valuable for both home use and market. Agawam—An excellent red variety.

STRAWBERRIES.

Fairfield (Perfect)—Medium size, dark red in color, excellent in quality. One of the best first early sorts. Warfield (Imperfect) Well known. Dark red in color, firm, high quality. Fine for culinary use and canning. Haverland (Imperfect)—An old favorite that holds its own in prolificacy beside all new-comers. Senator Dunlap (Perfect)—Rich in color, firm, high in quality. Plant vigorous, healthy and prolific. Blossoms sometimes fail to set fruit. Bubach (Imperfect)—An old favorite for nearby market. Lacks the essentials of richness and firmness necessary in a berry for home use and distant market. Sample—A reliable second early market variety. Parson's Beauty (Perfect)—A healthy, prolific, profitable variety for nearly all sections of Ohio. Latest (Imperfect)—A beautiful late berry that is fully as good as it looks. Rich, dark red in color, glossy and attractive. Flavor mild, sweet and delicious. The best of all late berries so far fruited at the Station.

BLACK-CAP RASPBERRIES.

Conrath—One of the largest and finest of the first early varieties. Cumberland—The largest of all varieties so far tested at the Station. Jet black in color, quality good. Does equally as well at home of the writer, in central Ohio. Munger—An improved Gregg. Large, late, handsome. Canes hardier than those of Gregg.

PURPLE-CAP RASPBERRIES.

Columbian—Berries very large, dull purple in color, but excellent in quality, both for dessert use and culinary purposes. Canes vigorous, hardy and prolific. Haymaker—Similar to Columbian.

RED RASPBERRIES.

King—Early, bright red, moderately prolific, hardy. Cuthbert—Well known. One of the best. Loudon—Large, dark red, handsome, prolific. Canes are quite subject to root or crown gall. One of the best where not affected by this disease.

BLACKBERRIES.

Early King—Hardy, reliable. Berries large and of fair quality. Eldorado—Unsurpassed for a home and market blackberry. Large, beautiful, sweet, tender, excellent. Canes hardy and prolific.

CURRANTS.

Red Cross, Wilder, Victoria and White Grape.

GOOSEBERRIES.

Downing, Josselyn. —(O. E. S., Cir. 55.)

KINDS OF FRUIT CULTIVATED IN THE UNITED STATES AND CANADA.

The kinds of fruit cultivated in the United States and Canada embrace nearly all known varieties. For a complete list of the cultivated fruits properly classified see table of "Fruits Recommended by the American Pomological Society for the United States and Canada" in Bulletin 151 of the Bureau of Plant Industry, Department of Agriculture.

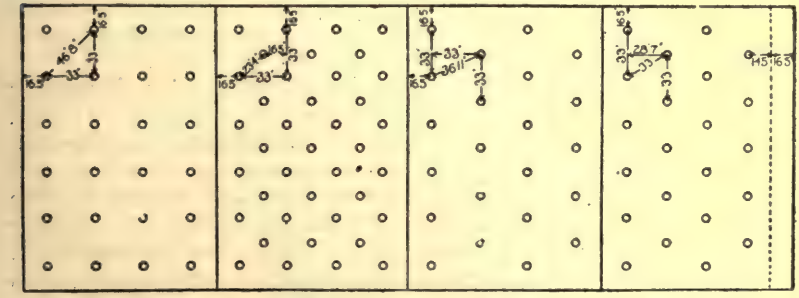
PREPARING THE LAND FOR PLANTING.

One of the first considerations in planting the orchard and in some respects the most important, is the preparation of the land. It is true that orchards can be planted on land that has been poorly prepared, but as a rule the difficulties which later arise more than offset the supposed gain.

Preparation for planting should consider at least the character of the surface soil, and the subsoil. With the ideal subsoil no attention need be given, but where the subsoil, or even the lower portion of the surface soil is a compact clay, then subsoiling should be done.

The surface soil should be considered from two standpoints—the character of the tilth, and the presence of organic material. While the former is more or less dependent upon the latter, the degree of firmness is a matter that should not be overlooked. A clover sod, or still better, a crop of clover, ploughed under, followed by a cultivated crop, preferably corn, grown upon the land puts the soil in the best possible condition for the planting of trees the following year. Frequent cultivation of the crop so as to put the soil in good tilth is essential. The clover which has been turned under adds both organic matter and nitrogen which assists in a vigorous growth of the trees the season planted. If the soil has been put in good condition little work is necessary in the spring before planting. The land may have been ploughed the fall previous or just before planting. Fall ploughing usually permits of earlier setting of trees.

Planting Plans.—There are numerous systems for planting orchards. Many fruit growers have worked out their own systems. Those mostly used are the rectangular, quincunx, alternate and hexagonal, or modifications of them, as follows:



Square Quincunx Alternate Hexagonal

The rectangular or square system is most used. In this plan the trees are set at the corners of a rectangular area. Most often the rectangle is a square, but not infrequently the sides are unequal. This is the simplest system to lay out. Its chief disadvantage is that it does not make economical use of the land, there being an area in the center of each rectangle little used by the trees. The Quincunx System was devised to offset the difficulty just mentioned. In this system an additional tree is set in the center of each rectangle. By this method the land is more fully occupied and the number of trees nearly doubled. In effect this system is doubling the number of rows and making the trees very much closer together. For example, where trees are set 30 feet between the rows, and 30 feet in the row, by the quincunx plan, the rows become fifteen feet apart, and the trees 21.25 feet from those nearest it. It will be seen that unless the rows are more than thirty feet apart, setting a tree in the center of the rectangle would so reduce the distance between the rows that difficulty would be encountered in orchard operations. This system is most often employed at present where fillers are used.

The Alternate System is designed to correct the difficulties arising from the former. It differs from it essentially in widening the distance between the rows, maintaining the same distances between the trees in the row, and is therefore better adapted to plantings under 40 feet. In the alternate plan with trees 30 feet apart in the rows the rows can be placed much closer together without reducing the space between the trees in adjoining rows so much as to interfere with orchard operations. By this method, the number of trees per acre may be increased, the land better distributed among them, and inconvenience in orchard operations avoided. It will be seen that this method approaches the hexagonal system for when the diagonal distance between the trees of adjoining rows equals that between the trees in the same row, then we have the hexagonal system.

The alternate system is frequently used in close plantings. In an orchard with rows 20 feet apart, set by the alternate system, it will be found much easier to get between the trees than if the rectangular system is employed for the distance between the nearest trees of the adjoining row will be approximately 28 feet, 3 inches or over 8 feet more than when set by the rectangular. Set at this distance the space between the trees of adjoining rows would be the same as when planted 40 feet apart by the quincunx. This system would seem therefore, to be preferable to the quincunx where trees are to be permanent and set less than 40 feet apart.

The Hexagonal System or equilateral triangle system is rapidly gaining favor as the most economical system for planting orchards. In this system each tree is equidistant from the nearest neighbor in any direction. The land is equally distributed among the trees, and it is practically all used without crowding the trees. It also has the advantage of increasing the number of trees about 15 per cent over the rectangular system without reducing the distance between trees.

Distance of Planting.—There is considerable controversy as to what is the proper distance between trees. It is impossible to give any hard and fast rule as to the proper distances as it will differ materially with climate and soil conditions, and the characteristic growth of the variety. There is always a tendency to plant trees too close. This is undoubtedly due to the fact that there is a desire to use as much of the land from the beginning as possible, and because newly set trees always have the appearance of being farther apart than necessary. Experience has proved that serious losses in the amount of fruit produced accompany close planting. Not only is the crop reduced, but orchard operations such as cultivation and spraying are interfered with in closely planted orchards.

Number of Trees Per Acre Under Two Systems of Planting.

Distance apart each way	Number of Trees.	
	Rectangular System.	Hexagonal System.
20 feet	108	124
25 feet	70	80
30 feet	48	55
33 feet	40	46
35 feet	35	40
40 feet	27	31

It is believed that apple trees should not be set closer than 25 feet in commercial orchards, and that in most instances, 30 to 35 feet will be found preferable. Table shows the number of trees at usual distances of planting. On large areas the figures will vary somewhat.

The Use of Fillers.—As previously stated, there is a considerable area unused by the trees in a newly set orchard. One of the methods devised for using this area is to plant temporary or filler trees. These fillers are either earlier bearing varieties of the same kind of fruit or some other kind of fruit. The fillers are left until they begin to crowd the permanent trees when they should be removed. It is doubtful whether the use of fillers should be recommended. The fact that most of our commercial sorts are quite early bearers precludes the use of earlier varieties of apple as fillers for the apple orchard. The peach is largely used as fillers in the East and South but is not sufficiently hardy for culture in the North, and if fillers are to be used the American plum seems to be the only fruit available.

There is another objection to fillers which makes their value questionable. Most growers leave the fillers so long before removing them that the permanent trees are seriously injured. Perhaps the fault should not be charged to the system, but so long as it constantly occurs it needs to be considered. The grower should be confident that he is willing to remove trees producing good crops in order that all the trees may not be permanently injured. Fillers are not necessary for the utilization of the open area between newly set trees.

Laying Out the Orchard, Wire Method.—There are numerous methods of laying out and staking land preparatory to orchard planting. One of the most convenient and efficient on small areas, which are comparatively level and set by the rectangular system, is the wire method. Stakes are set along two sides of the orchard beginning at the desired distance from the fence, usually 15 to 25 feet, and then at intervals equal to the distance the rows are to be apart. In setting these stakes, care should be taken to begin at the same end for both rows and to have the distance between stakes exact. A wire sufficiently long to reach across the field is then stretched between the corresponding stakes on opposite sides. Telephone wire or even smaller wire may be used. Number 14 wire has been used successfully on small areas. Fine wire or other markers should be fastened on the wire to mark the proper distance between the trees. The wire should also be provided with loops or rings at the end so that it may be kept well stretched. Small stakes are set at the points indicated by the markers, and the wire then moved over to the next stake at each end ready to make the second row.

While designed for the rectangular system, this method can also be used in the hexagonal system by having the first marker of the even numbered rows come half way between the first two trees of the preceding row, and by having the distance between the rows as shown in the following table:

Distance Between Rows in the Hexagonal System.

Distance between trees.	Approximate distance between rows.
20 feet	17 feet, 4 inches.
25 feet	21 feet, 8 inches.
30 feet	26 feet.
33 feet	28 feet, 7 inches.
35 feet	30 feet, 4 inches.
40 feet	34 feet, 8 inches.

Lining-in Method.—A method very commonly used in setting an orchard by the rectangular system is the "lining-in" method. Stakes are set on both sides and ends of the area to be planted. Lath serve the purpose very well. The first stake should be the proper distance from the fence, and the others at intervals equal to the distance between the rows. Two rows of stakes are run through the center of the area at right angles to each other, care being taken not to have them come on the line of the row, which is easily done by starting between two of the stakes on the end. These stakes should be in line with the stakes running parallel to them. The man setting trees now has two stakes in each direction by which to line-in his trees. By this method all intermediate stakes and the planting board may be dispensed with.

Marking with the Plow.—When large orchards are to be planted, the item of digging the holes for the trees is an expensive one. To reduce this to a minimum, marking out with a plow is a very good method. The method for staking is much the same as when the wire is used for locating the trees. The position of the first row should be determined and stakes set near each end. Each succeeding row is marked in like manner. If the ploughing is to be done in but one direction, the distance between the trees may be determined by one of the methods previously mentioned. When done in both directions, the other sides of the area should be staked out in the same way as the first two. It is usually found advantageous to have other stakes set in line between the end ones, particularly if the rows are long or the site rolling. With a steady team and good driver, the rows can be gotten reasonably straight, but it is always desirable when this method is used to be very careful in getting the trees of the first two rows and the first two trees of each succeeding row in exactly the right place, and then line in the other trees of the row. In doing this, working two men together will greatly facilitate planting.

Staking for Hexagonal System.—One method has already been given for staking for the hexagonal system. Most methods which are used in laying out the orchard by the rectangular system can be employed in the hexagonal system if the following facts are taken into consideration. That in the hexagonal system the distance between the trees in the row are the same as in the rectangular system, but that the distance between the rows is less. Also that the trees of the even numbered rows are midway between the trees of the odd rows. It would be more difficult to use the plow in one direction in planting by this system than by the rectangular.

Another method is frequently used in staking out the hexagonal orchard. The first row is located with reference to the fence and becomes the base line. Beginning at the selected position of the first tree, stakes are set at the desired distance between trees, a wire the length of the distance between trees is then used for the location of the remaining trees. It is convenient to have a ring at each end of the wire as this facilitates handling. If the rings are used the length of the wire should be considered as extending from center to center of the rings. One ring should be fitted with a marking pin, this end to be used by the man locating the position of the trees.

The method of locating the trees follows:—A holds the center of his ring over the first stake of row 1, while, B takes the marking end and strikes an arc at what he thinks is the location of the first tree of the next row. A walks to the second stake of the first row, and B again strikes an arc. At the intersection of these arcs he sets a stake, locating the position of the tree. B then strikes an arc where he thinks the location of the second tree will be. When all the trees of row 2 are located, it becomes the base line from which to locate trees of row 3. If the ground be uneven, a plumb bob should be used so that the wire may be kept horizontal. In locating the end tree there is frequently but one stake from which to strike an arc. The location is easily determined, however, by locating the second tree first, and then use it as the point from which the arc is struck. After three rows have been located by the arcs, others may be lined in.

SELECTING TREES FOR PLANTING.

Although nearly every person who plans to conduct an orchard and who buys fruit trees is particular as to the character of the tree which he buys, nevertheless, thousands of trees are planted every year which are not suitable for orchard purposes. That this condition should exist may be due to the combination of a number of causes. There are three, however, which will account for the planting of the greater portion of inferior trees.

Very frequently the buyer has no well defined idea as to what the tree should be. A second cause is that he does not state explicitly in his order just what kind of trees he wants. Even if he fulfills the first two requirements, he often fails to refuse stock which has been sent to him which does not come up to the specifications in his order. Even though he knows that they are practically worthless he plants such trees simply because he does not care to take the trouble to make the nurseryman furnish him good goods or because of the delay that will be entailed.

The nurseryman is not always to blame because a buyer gets inferior trees. There are many things which makes the filling of nursery orders difficult, but probably the chief reason why so many poor trees are sent out from the nursery is because the average buyer is dissatisfied unless he gets a large tree with a heavy top. In his attempt to satisfy the demand for large trees, the nurseryman very frequently is obliged to sacrifice the very things which would make the tree most valuable.

Some buyers apparently think that all varieties grow alike, and having an ideal in mind, want all trees to come up to that ideal. Such a thing is impossible. A Fameuse tree will not grow like a Northwestern, any more than a Jersey cow will resemble a Shorthorn, but because it will not do so does not mean that it is inferior to the Northewestern. The first thing the buyer must have in mind is what the ideal for the variety is, and then judge his trees accordingly. There are some general requisites, however, which can be considered in common.

Age of Trees for Planting.—Unfortunately nursery trees are commonly sold by size rather than age. Size is not necessary a criterion of the worth of a nursery tree. In fact, it is a worthless factor in judging unless considered in connection with age. A six foot tree may be four or five years old, but it would be a much poorer tree than one of the same variety four feet high and three years old. A great many trees are being carried in the nursery until they are long past the best age for planting, simply to get them to a large size. This is particularly true of slow growing varieties.

The true standard then, for buying trees is the age. In this course, size should be considered to the extent that the tree should be of good size for the variety at that age. A two-year-old Fameuse then would probably be much smaller than a two-year-old Duchess or Northwestern.

How to Determine Age of Trees.—It is very easy to determine the age of a nursery tree. The age is counted from the budding or grafting. The end of each year's growth is marked by a row of rings or scars around the trunk and branches. To tell the age of a tree, begin at the tip of a branch and follow back to the base of the tree, counting the scale rings. The tree will be one year older than the number of rings. It is best to use the branches at the top. In trees on which the tips of the branches have been injured or removed, during the summer, some difficulty may be experienced in determining definitely but this method will serve in most cases without difficulty.

The best age at which to plant trees is a much mooted question. The present tendency is to plant trees which are too old. The upper limit of age for an apple tree is three years. Two-year-old trees will be found better than older ones in most cases. The present demand for large trees causes the nurseryman to prune off the side branches along the first and second year's growth, thus in a great many instances spoiling the shape of the tree or at least making it necessary to form the head too high.

Another factor which tends to give inferior trees where they remain long in the nursery is the fact that they are grown very close together, and this forces the branches to grow more in one plane which result is lop-sided trees. The shorter the period the tree passes in the nursery, the more likely it is to be a good tree when the grower receives it.

It is true the younger trees require longer to come into bearing after being planted, but the orchardist can better afford to give them one or two additional years attention and have the opportunity to prune and care for them so they will make first class trees, than to let the nurseryman grow them for the additional length of time, and have to give the same amount of care later on in trying to change a spoiled tree into a passably good one. It is not the intention to convey the idea that no good three-year-old trees are produced in the nursery, but with the present systems and practices the chances are very much against it.

The two-year-old tree is probably the best for commercial planting, although one-year-olds are very popular with many large growers. The former is a compromise age as the two-year-old is less likely to have been spoiled in the nursery than an older tree, and it saves one year in the orchard before bearing. If, however, suitable two-year-old trees cannot be secured, by all means use the younger trees.

Best Height of Head.—By "height of head" is meant the distance between the base of the tree, after planting, and the height at which the main branches grow out. Formerly trees with branches lower than five or six feet were not desired because when lower they were supposed to be very difficult to work under. Today no good commercial orchardist would think of planting trees with such high heads. There are numerous reasons why a low-headed is preferable to a high-headed tree, but the chief one is because it facilitates orchard operations. In this day of pruning and spraying and high prices for labor in picking, the orchardist does not want a tree so headed that it will require a ladder to reach the lowest branches producing fruit. The old objection that the lower branches of low-headed trees interfere with orchard cultivation is easily met by the fact that a great many trees have a habit of growth which permits work under their branches even when low-headed without additional inconvenience. Those which do not have such a habit can be improved by proper pruning, and the head need be only a little higher than in the others. The low-headed tree, therefore, is rapidly becoming the only one used in commercial plantings.

The question is often asked, "What is the proper height to head an apple tree?" Authorities differ, some giving one foot as the desired height, others as much as three feet. It is scarcely wise to make any hard and fast rule as the height which will be found most advantageous will vary with different varieties. For up-right growing varieties like Wealthy and Northwestern, 18 inches to 2 feet will be sufficient. Varieties like Longfield with a spreading habit and slender branches should be headed somewhat higher.

Distribution and Number of Branches.—The proper distribution of the main branches is one of the most important things to consider in the young tree. It has already been stated that the closeness of planting in the nursery row frequently causes all the branches to form on two sides of the tree, or to become so curved that when set in the orchard there are branches only on two sides. Good trees can seldom be formed from these trees. The branches should be well distributed around the trunk, and sufficient in number so that if any form V-shaped crotches, they may be removed. Usually four to five branches will be sufficient from which to select the foundation for the head of the tree. These branches should be good, strong ones. Frequently a nursery tree has only small slender branches arising from the trunk at the height desired for forming the head. This is usually due to improper pruning in the nursery row. Such trees are not first class and should be refused.

Deal Directly with the Nursery Man.—Three-fourths of the trouble which arises over the tree purchases could be avoided by ordering directly from the nurseryman rather than through a nursery agent. Almost invariably they will push the "novelties" which are high-priced, and which later turn out to be worthless. It is usually a good practice to let some one else try out the new sorts.

All bona fide nursery agents in some States must have an agent's certificate issued by the State Nursery Inspector. This certificate gives the name of the firm the agent represents. A purchaser has the right to see the certificate and if the agent fails to show it upon request, do not risk signing any contract which he presents.

Where any considerable number of trees are to be purchased, there are other reasons than those given above for dealing directly with the nurseryman. The agent has a set order to be filled out which gives the number, kind, and size of trees wanted. It says nothing whatever about the height of the head, number of branches and age of the trees which are quite as important as the items which it enumerates. When you order directly from the nurseryman you are able to get these items in the order with the result that if the nurseryman values your future orders, you will usually get better stock because he knows exactly what you consider first class stock. In the other case, he would have no idea concerning your preferences.

State Character of the Trees Desired.—As has been suggested above, this is one of the most important essentials in ordering stock. It is not necessary to state the definite size of tree but it is very important to give the age. The order should read about as follows:—"Trees to be two years old, typical of the variety, and of good size for the age; heads to be not over 24 inches high (somewhat higher in spreading varieties), four to six well distributed branches and free from disease or serious blemish."

When such an order is given, refuse goods which are not up to the standard. It is a waste of time and money to set inferior trees and attempt to make them desirable later on. This usually results in putting up with an inferior tree and very frequently, in commercial planting, of the removal and replacing of the tree later on. If you make it sufficiently clear in your order that nothing but first class trees will be accepted, there is usually very little difficulty over inferior stock.

Refuse Substitutions.—Nearly every nurseryman retains the right of substitution on his regular order. When you sign the order blank presented by the nursery agent, you endorse a clause essentially as follows:—"In case the supply of any variety has been exhausted, we retain the right to substitute a similar variety of our choosing." In ordering from the agent, be sure that on your order there appears "No substitution allowed." If this is done, no dispute can arise over substituted stock. In ordering directly it is not usually necessary to make this statement, but it does no harm and is a wise precaution.

Keep a Copy of the Order.—While a mere detail, keeping a copy of the original order is important as it often saves disputes and frequently more serious trouble.

Be Willing to Pay a Good Price.—It is a very serious mistake to try to cut the cost of trees too much. Cheap trees are usually poor trees. It is not necessary to pay exorbitant prices in order to get good trees, but it is better to pay exorbitant prices and get good trees than to buy poor trees at cut rates. The original cost of the tree is of minor importance to its ultimate value. Ten or even 25 cents saved at the start by buying an inferior tree is usually expended several times later on in trying to make a good tree out of a cull, and usually with very little success. Ten cents per tree increase in cost is only about $7.00 an acre, and very often means the difference between success and failure. Paying a high price for a tree does not necessarily mean that it will be a good one. Pay enough to get the best and then refuse any which do not come up to the standard.

Another item which increases the cost is replacing stock. The general practice of Wisconsin nurserymen is to replace stock which dies the first season. In order to do this they add considerable to the real price of the tree in order that nothing will be lost by replacing. Such a practice invites carelessness in handling and setting the trees. In addition, it works a hardship on the careful man because he is compelled to help pay the cost of his neighbor's carelessness. Almost always the grower will find it worth while to carry his own risks if he orders good trees and is careful in planting them. In writing for quotations on trees he should state that he does not want his trees "guaranteed," and the nurseryman will make a considerable reduction from his regular price. Many nurseries outside of the state do not "replace" stock which dies the first year, and in comparing prices with those quoted in the catalogues this should be taken into consideration.

Care of Trees on Arrival.—Very often trees arrive before local conditions permit of their being planted. It is a serious mistake to leave trees for any considerable period in the packages in which they arrive. Not infrequently trees which arrive in good condition are allowed to remain in the packages several days with the result that when they are taken out they are seriously injured if not rendered entirely worthless.

The object should be to get the tree into the soil as soon after its arrival as possible. If it cannot be planted, it should be "heeled-in." Select if possible, a protected place as on the north side of a building or fence. If a large area is to be planted, it will be found convenient to heel-in the various varieties along the side of the area near their location in the planting. If the trees are in small bundles, and are to remain only a few days, the bundle will not need to be opened although the work is facilitated if this is done.

Dig a trench about 18 inches deep one side slanting at an angle of about 30 to 45 degrees, depending upon the amount of protection desired of the branches. Place roots of the trees in this trench and cover with earth, packing it down so that all the roots are in contact with the soil, but not tight enough to break the roots. If one trench is insufficient to hold all the trees, take the earth from the side of the trench opposite the tops. In this way a trench for the second lot of trees is dug without additional labor. Where several varieties are to be heeled-in the same place, it is a good plan to put one variety in each trench as this insures keeping the varieties separate without relabelling all the trees. If trees are heeled-in in the open where exposed to the sun, the tops should be placed towards the south and the angle with the ground increased so as to give the trunks more protection. Properly heeled-in trees may be left for reasonably long periods without injury.

Time for Planting.—A great many fruit growers in Wisconsin and other parts of the Northwest are misled as to the best time to plant trees by reading articles written by Eastern or Pacific coast growers on the benefits of fall planting. While autumn may be the best time for these growers to set their trees, it is a poor time for the Wisconsin grower if he expects to have many of his trees survive the winter. Climatic conditions are so much different than in the Eastern states of like latitude that the best practice is also different.

Winter killing of trees in Wisconsin is the result of drying out of the trees accompanied by low temperatures. Northwestern winters are cold and dry, while Michigan and the Eastern states have a more moist climate and higher temperature. A newly planted tree has been deprived of the larger portion of its root system, and if set in the fall has no chance to develop a new one or become established before winter. As a result it is in the poorest condition for supplying its top with moisture. Unable to furnish as much moisture to the top as is lost by evaporation, the tissues of the plant become dried out to the extent that the growing parts are killed or so severely injured that the tree is unable to resume growth in the spring. The arguments advanced in favor of fall planting are so greatly outweighed by this one condition that fall planting cannot be recommended for Wisconsin, and other similar sections of the Northwest.

Trees should be planted as early in the spring as soil and climatic conditions will permit. If, for any reason, planting has been delayed, it can be done well into May, particularly if the trees have been carried in a storage cellar, and are in a dormant condition. Trees may be set when in leaf, but this is far less satisfactory than when they are dormant.

Setting the Trees.—There are several items which need careful attention in setting the tree. One of the very first is getting the tree in the proper position. In many of the systems of laying out an orchard a stake is set to mark the location of the tree. As the stake is removed to dig the hole, difficulty arises in getting the tree in the position occupied by the stake, as very frequently the root system of the tree is such that the hole cannot be dug symmetrically. To obviate this difficulty, the planting board is employed. There are two forms of planting boards commonly used. The more common one is made from a piece of board about 6 feet long and 6 inches wide. A notch is cut in one side at the center, and a hole bored at equal distance near either end. These holes are provided with wooden pins. The notch of the planting board is placed over the stake locating the tree and the pins stuck in the ground through the holes in the ends. The board and stake may then be removed, and the hole dug. Replacing the board over the pins shows the exact location of the tree. Another form of planting board is the equilateral triangle. Three laths or narrow pieces of lumber are fastened together so that they form a triangle with the ends projecting as shown in figure 12. Care should be taken to have the distance between each two adjoining corners equal as this will relieve the necessity of replacing the triangle in the same position. One projecting end is put over the tree stake, and the pins placed in the others. This marks the location of the tree after digging the hole the same as with the former.

Size of Hole for Planting.—The size of the hole for the tree depends upon three factors, extent of the root system, character of the soil, and height of heading. The size of the hole in relation to the extent of the root system varies from that made by the crow-bar, as used in the "Stringfellow" system of planting to two feet or more square. Under normal conditions the size of the hole would be such as will conveniently admit the root system without crowding. In most cases this will be about 15 to 18 inches square. As a usual thing the root system should not be reduced just to make it go into the hole even though this is the easier and quicker method.

Where the soil is heavy and compact and has not been put in proper condition of tilth prior to planting, the hole should be considerably larger. In this way the soil in the bottom of the hole may be loosened as well as that at the sides of the hole and the root system given a better chance to develop.

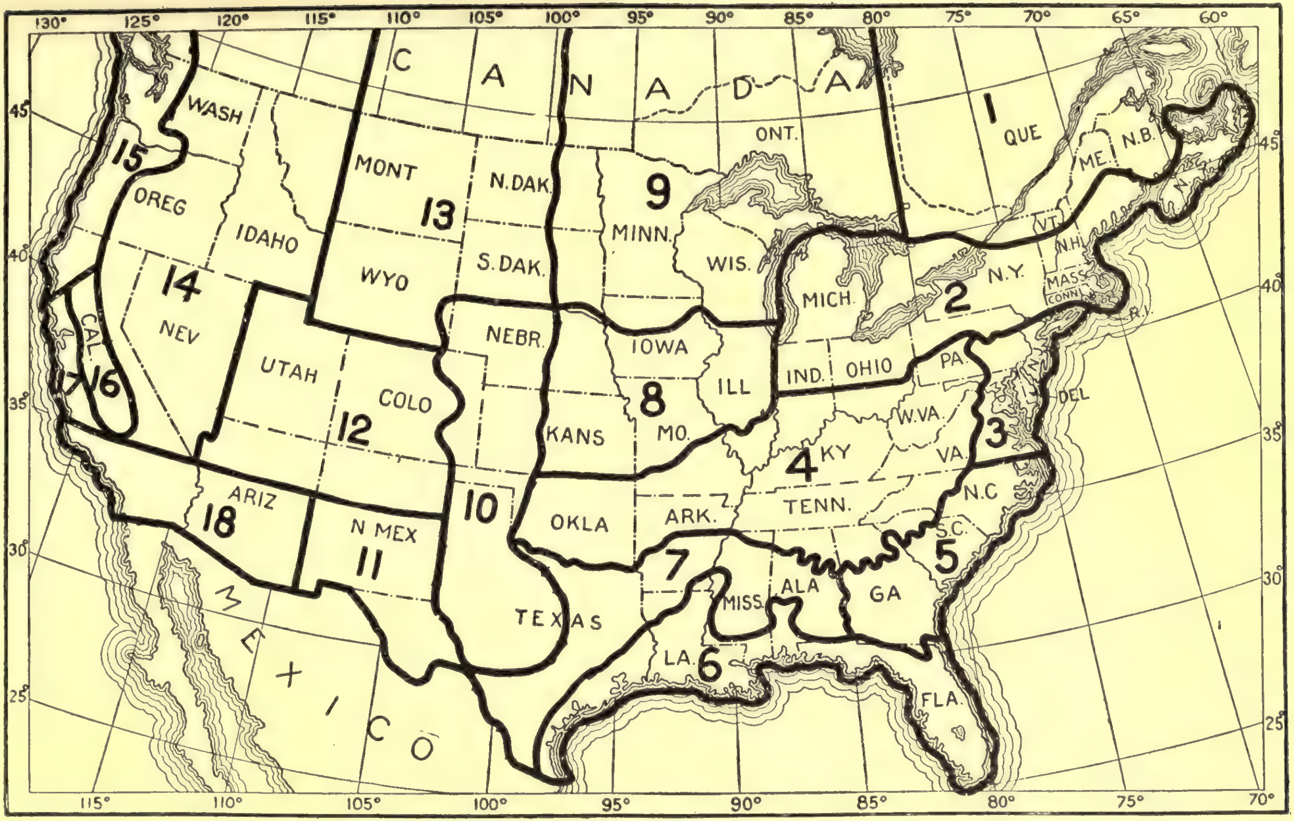
With normal soil conditions the depth will be largely influenced by the height of the head, although there are other influencing factors. The general rule is to set the tree somewhat deeper than it was in the nursery. Horticulturists differ as to the best depth for planting, but usually advise from 3 to 5 inches deeper than in the nursery. Root grafted trees, which are mostly used, should be set low enough so that the union of the stock and scion comes some distance below the surface.

Where one desires low-headed trees, and has been unable to secure them, the height of the head may be somewhat reduced by deep planting. If this is done, however, it should not be carried to extremes even if necessary to sacrifice something in height of head. It is probably not best to set trees much if any over 8 inches deeper than they were in the nursery. Roots placed too far below the surface are unable to perform their function as well as if nearer the top of the ground.

Root Pruning.—Root pruning is one of the essentials to best results in planting trees. As a rule, more than enough of the root system has been removed by the nurseryman in digging and so farther reduction is not desirable from that standpoint alone. Injury in digging and shipping, however, makes slight root pruning before planting desirable. The object should be to put the root system in as good shape with the slightest amount of removal as possible. Practically no attention need be given the small roots. The ends of the large ones, however, will demand attention as the wounds in digging are left rough and splintered. The ends of roots should be cut back far enough to secure smooth wounds to facilitate healing. Badly broken or split roots should be removed.

Root Distribution.—The roots should be as well distributed around the tree in planting as possible. Frequently they are practically all on one side, and under such conditions it is difficult if not impossible to have them properly distributed. In such cases care should be taken to have the greater part of the roots on the side on which they will give the greatest support to the tree. The chief thing to consider will be the prevailing wind.

Slant of Tree in Planting.—It is usually a good practice to slant the tree more or less when planting. The amount of inclination varies in different sections depending mainly upon exposure to high winds. Slanting at an angle of 8 or 10 degrees will usually suffice. Not only does this inclination help prevent the trees from becoming up-rooted, but it also aids in protecting the trunk against sun scald. On hilly sites the trees should be inclined up hill even



Map Showing Pomological Districts of U. S. and Canada. Dept. of Agr.

though the wind be from the opposite direction. In the latter case, however, the inclination will be less than if the site is protected from heavy winds.

Filling the Hole.—A great many newly planted trees die because of carelessness in filling the hole. It is important that this work be carefully done. If the soil which was removed from the bottom of the excavation be hard and lumpy, it should be placed to one side and the surface soil used first in filling. The main thing to remember in filling is that every part of the root system should be in contact with the soil. Unless it is the exposed areas will be points for the loss of moisture and the drying out of the roots. The soil surrounding the roots must be fine if they are to be well covered. Either loosen the soil in the bottom of the hole, or throw in two or three spadesful of loose earth so that when the tree is put in it will sink sufficiently into the soil so that all under surfaces will be in good contact with it.

The soil may then be filled in using the fine soil first, and compacting it well around the roots. There is little danger of compacting the soil too much unless it be of a clayey nature, and somewhat moist. After the first few spadesful have been put in, the soil may be packed by tramping. Be careful in compacting the soil not to crowd the tree out of place. The soil should be mounded at the base of the tree above the natural level of the land; the top two inches being left as loose and fine as possible.

Avoid Fertilizing Young Trees.—It is a very common practice to fertilize newly set trees with yard or stable manure. This practice should not be followed. The first activity of a newly set tree should be to develop an extensive root system. If large amounts of plant food materials be placed within easy reach of the tree, the root system will be confined to a comparatively small area. After the supply of food materials provided at planting have become exhausted, the roots will not have developed sufficiently to secure sufficient food to keep up a normal growth of the young tree, and what was supposedly gained at the beginning will be more than lost by the check which the tree receives.

Watering Benefits Little.—Under normal conditions little if any benefit is derived by watering newly set trees. In the first place, enough water seldom is applied to moisten the soil around the roots. If water is to be given it should be applied in quantities sufficient to nearly saturate the soil to some little depth below the bottom of the roots. Another mistake which is usually made is in applying the water on the surface after the hole has been entirely filled. If water is to be applied, it should be either put on before the top two or three inches of soil are filled in, or if applied to the surface as soon as the soil is sufficiently dry the surface soil to a depth of two inches should be cultivated and put in a fine tilth.

Litter Mulching Gives Slight Benefit.—Practically the same objections which have been raised against watering can be offered against mulching. It is expensive, and as a rule, not enough mulch is applied to be of any material benefit. Frequently stable manure is used, and this adds to the objections of the practice. Mulching, as it is commonly understood, means putting litter of some kind around the base of the tree for the purpose of conserving the moisture and protecting the roots from too much heat transmitted through the soil. The most efficient and least expensive mulch for this purpose is not one of litter, but one obtained by keeping the surface soil around the base of the trees in good tilth. If kept fine and loose, the dust mulch is more efficient in conserving moisture than the litter mulch, and at the same time retains the moisture at the point where it is needed rather than at the surface of the soil, as does the litter mulch.

Top-Pruning Young Trees.—Probably more trees die the first season after planting from lack of proper top-pruning than from any other one cause. One frequently sees newly set trees in which the top has been left exactly as it came from the nursery, or at most, only a small amount of the growth removed. Scarcely, if ever, does the grower prune his trees too severely at setting; in almost all cases not enough is removed.

Top-pruning should be done just as soon after planting as possible, as every day it is neglected lessens the chances for the tree to withstand the adverse conditions. There are two reasons why top-pruning immediately following planting is of so great importance. First, it is the means of equalizing the root and top area; second, it is the most important pruning, as a rule, in the formation of the head of the tree.

As has been previously stated, when a tree is dug, not only is the root system mutilated, but by far the greater portion is removed. Often four-fifths of the root area is left in the nursery as the root extent of a good, healthy tree is greater than the extent of the top. It is readily seen then that if the top of the tree is not reduced, this mutilated and greatly lessened root area is called upon to supply as much top with moisture and food materials as the entire root system did previously. If the roots have not been too greatly reduced, and conditions are favorable, the tree may succeed in getting through the first season, but never in first class condition. The moisture supply is insufficient, the tips of the branches dry up and die, and not infrequently the bark of the entire top becomes more or less shriveled, which is a clear indication that the tree is being severely injured. If the tops had been reduced, the moisture and food now going to numerous branches would have been supplied to a few and these injurious results largely, if not entirely, avoided. Very often where no top-pruning is practiced, and climatic and soil conditions are adverse, the tree dies without putting out any new growth. It is evident then that fruit trees should be heavily top-pruned immediately after planting.

But of slightly less importance in pruning after planting is the forming of the head of the tree and the selection of the branches which are to form the foundation for the top. No absolute rules can be given for pruning for this purpose, because each tree offers a different set of conditions. A few general suggestions will be of value in determining the extent of cutting back.

The very first consideration in top-pruning is the height of the head. It is not always possible to secure the head at the desired height, but if the directions under "Ordering Nursery Stock" are followed, but little difficulty will be experienced in this regard. Sometimes it is necessary to remove better branches to secure the desired head than some which are to be left, but if those left are average, then the lower heading is to be preferred. The number of branches to be left, and their position, depends somewhat on the character of the top desired. There are two forms of tops used: the open or vase form, and the close centered. Where the growing season is short, the open centered form is most desirable. This means that in pruning the central leader or the branch making the upright growth from the center should be cut out.

Too many main branches are usually left. Four are sufficient and frequently three on strong growing trees will be enough to give a good top. If too many branches are left at the start, the top becomes too thick, necessitating the removal of one or more later on. This can seldom be done after the second year's growth without injury to the form of the tree. The removal of a large branch after this period leaves a hole in the side of the tree which is difficult to fill. Had the branch been removed in the first pruning, the others would have filled in the space, and the tree would have been symmetrical.

The branches which are chosen should be as nearly equally distributed around the tree as possible. If they are unevenly distributed and the space wide, they should be so pruned as to throw the growth from the top bud of each of the adjoining branches into the vacant space. Avoid having the branches come out from the trunk too close together. They can extend along the trunk for 18 inches, and although they may appear spaced too far at first, when the tree has reached the bearing age, and the branches have developed, they will be close enough together. Choosing branches which arise at practically the same height gives bad crotches which are liable to become sources of trouble later on. Avoid as much as possible V-shaped crotches. They are weak and the branches are very likely to split down under high winds or heavy loads of fruit. Some varieties are prone to this form of crotch, and therefore should be given extra attention in this respect.

Cutting Back the Top.—No point in top-pruning after planting is more discussed and disagreed upon than the extent of cutting back of the branches chosen for the foundation of the head. All agree that they should be cut back somewhat in order that the new branches may be forced out nearer the head of the tree. If not cut back the buds near the tips of the branches will produce the strongest growths, but they will be so far from the head that if left, the branches will be more likely to break down under heavy fruiting. The main branches are usually cut back, leaving them from 6 to 18 inches long. Eighteen inches is the maximum length under normal conditions, and there is little doubt that in most cases 12 inches would be a better maximum than the greater length.

There is one point to be remembered in cutting back the branches. Do not cut back beyond the last season's growth unless the previous season's growth has good, strong buds from which to produce new shoots. Good, strong, main branches seldom arise from side shoots on two year old wood, and in forming the head of the tree such a practice will usually result disastrously.—(Wis. E. S. B. 201.)

Pruning the Bearing Orchard.—Pruning is one of the most neglected practices of good orchard management. Neglect of the trees in this respect does not usually show its injurious effects as readily as lack of spraying or fertilization, and for that reason is frequently considered of minor importance. No one at the present time argues that rational pruning is detrimental to the tree, but it is a fact that in a very large majority of the orchards no rational system of pruning is followed. The little that is done is usually haphazard, and spasmodic, and not infrequently more injurious than beneficial.

Neglected pruning especially of young trees can never be corrected so as to give as good a tree as though the work had been done at the right time. The first pruning is the most important factor in the history of the plant, but those immediately following it are of only slightly less importance. If the tree be properly pruned during these years, the matter of pruning after it comes into bearing is a great deal less troublesome problem than if the work has been only half executed.

Pruning during the early stages of a tree's development has for its primary object, the formation of an ideal fruit bearing area. Making up this ideal are such factors as proper branching, keeping the head open, encouraging the production of fruit spurs, correcting defects of growth, and keeping the head down so that spraying and harvesting will be facilitated. To secure this ideal or even approach it, pruning must be done at least once each year, and when done not be a matter of merely going through the orchard and clipping out a branch here or there. Each tree must be carefully studied as to its individual characteristics and then pruned accordingly.

The Time to Prune.—It has been said that the best time to prune is every month in the year. If carried out consistently, this is undoubtedly true, but most growers would find it inconvenient to do so. Pruning is not confined to any distinct periods or seasons. Some of the best growers carry heavy pocket knives and whenever these see a small branch which is undesirable, they remove it. As a rule, however, pruning as a distinct practice is performed during late summer, and known as summer pruning, or during the dormant period and called winter pruning.

Summer pruning tends to induce fruitfulness in trees which are prone to throw all their energy into vegetative growth, but it is a devitalizing process. Followed for any considerable period it causes a decline in both vigor and fruitfulness of the tree. It cannot be recommended as a general practice. Winter pruning may be done at any time during the dormant period. Late winter or early spring is preferable to early winter under Wisconsin conditions. Where branches are removed early in the dormant period, the wounds make no progress toward healing until growth starts in the spring. These wounds permit a much more rapid evaporation of moisture from the tree and unless carefully protected are very likely to check and become favorable places for fungus and bacterial diseases to gain a foothold. The delicate cambium layer which forms the new tissue for healing the wound is also likely to be killed back for some distance from the edge of the wound, making it a very much more difficult matter to secure proper healing. If done in late winter or early spring, just before growth starts, the probability of injurious results is materially reduced.

Second Season's Pruning.—Pruning the young tree the second season after setting consists primarily in removing the superfluous branches which have been formed on the main branches chosen at the first pruning, and in shortening the growth. The tendency to leave too many branches the second year is almost as great as at the first pruning. Two or three strong branches, depending upon the number of main branches left will be sufficient to fill in the head. They should be well distributed on the main branches, and quite near the base of the branch so as to keep the top of the tree low and the foundation strong. Branches with a tendency to grow into the center had best be removed the second season as there will be sufficient time to thicken up the head later on. Those chosen for further development of the head should be shortened or headed-in. The amount to be removed will depend upon the extent of growth during the past season, and the character of the tree. Occasionally heading-in will not be necessary, but as a rule from one to two-thirds of the past season's growth should be removed. Trees with a weak, slender growing habit will be cut back more than those making strong, heavy branches.

At this pruning, precaution should be taken to correct any defects in the direction which the branches are taking. If there are open spaces being left in the top, prune so the top buds of branches on either side will be on the side next to the opening. If the branches have a tendency to grow too upright, cut back so that the top bud will be on the lower or outer side; if they spread too much, have the bud on the upper or inner side. Pruning back to a particular bud is of great importance in the early pruning of a tree if the best head is to be secured. Many growers pay too little attention to this matter when heading-in.

Choose, if possible, a good strong bud in the position in which desired. In cutting back, make the cut just above this bud. A strong knife will be found best for this purpose. Cut across the branch diagonally, beginning at about the level of the bud on the opposite side of the branch, and come out on the other side about an eighth of an inch above the top of the bud. This leaves the bud protected and gives a wound which will heal rapidly.

Third Year's Pruning.—If the pruning during the first two years has been properly done, that for the third year will require less attention. The frame work of the tree should be formed by this time so that the pruning will consist almost entirely in removing superfluous shoots and cutting back the new growth which is to be left. Branches which rub or are inclined to form bad crotches should be removed. Too many branches should not be allowed to grow into the center of the tree as it is desirable in Wisconsin to keep the head quite open to permit the entrance of sunlight and allow good air circulation through the top. Pruning for subsequent years will follow closely that outlined for the third season.

Pruning Neglected Trees.—One may find himself in possession of an orchard in which the pruning has been neglected. Putting such trees into good condition is quite a difficult problem. The first thing that the grower should realize is that usually this operation will require more than one year. As a rule the top of a neglected tree resembles a brush heap. It is very dense and a large proportion of this growth should be removed. However, if this is done in a single season, the tree is forced into heavy top growth, and conditions are almost as bad at the end of the season as they were at the beginning.

In pruning a neglected tree the first thing is to cut out the dead wood. This should be followed by removing the water sprouts or suckers that have arisen from the main branches. If these are not numerous, the more seriously interfering branches will next receive attention. Usually this is about all that it is advisable to do the first season unless it is the intention to replace the old top when, of course, the pruning will be much more severe.

Pruning the second season consists in removing the new growth of water sprouts and further opening up the top if desirable. Unless the top is to be renewed, it is advisable to remove no more large branches than is necessary as this is likely to leave large openings in the tree. If the tree has begun to make much growth at the ends of the branches, these twigs may be headed-in as in the regular pruning.

Spasmodic Pruning Undesirable.—Pruning should be an annual operation. Many growers prune at intervals of three or four years, but this is a very undesirable method. In the first place, it will take less time to prune properly when done at least once every season than to let the growth accumulate for three or more years, and the results will be much more satisfactory. A small branch or twig is much more quickly removed than when it has grown for a considerable time; it has not made so large demands upon the tree for its food supply and has caused no evil effects by crowding other branches which it is desirable to leave for permanent use.

When done at long intervals, pruning has a tendency to disturb the equilibrium of the tree, and to retard or diminish fruit production. It is evident that if no pruning is done on a tree for a period of years, that the amount of wood to be removed at one time will be much greater than if annual pruning is practiced. Heavy top pruning tends to wood production. As a tree cannot turn its activities strongly in two directions at the same time, it follows that fruit production will be reduced until the tree has regained its equilibrium. This balance is quite difficult to obtain for the vigorous vegetative growth induced by the heavy pruning runs quite largely to the production of water sprouts or suckers which are worthless, as a rule, and should be removed. These difficulties can be almost entirely overcome by practicing annual pruning.

Wounds, Their Making and Treatment.—Neglect or improper making of wounds frequently result in serious injury or even premature destruction of the tree. Neglect in pruning is usually accompanied by carelessness in making and neglect in caring for the wounds. Just the reverse should be true for the wounds will be larger and if they are to heal, the utmost care should be taken in these respects.

In pruning young trees or where thorough annual pruning is practiced a strong knife and small hand shears are all the tools that are necessary until the tree reaches the height where a pole pruner will be needed for heading-in the top branches. On newly set trees, a strong knife is more desirable than the hand shears because the branches can be cut off nearer the trunk. By cutting from below upward toward the trunk or branch to which it is attached, quite large branches may be removed without difficulty. Care should be taken as the branch is nearly severed that the knife does not come through suddenly and injure other branches which are to be left. In removing branches with the pruning shears, put the blade next to the trunk or main branch and press the branch to be removed away from the blade.

Removal of large branches is a more difficult proposition as there is danger of the branch breaking down and splitting into a ragged wound, or pulling off large areas of bark. To avoid this, double sawing is usually desirable. It consists in cutting the branch off some little distance from the trunk or main branch, and then removing the stub. In the first sawing, it is well to saw one-third to one-half through the branch from the under side, then finish the sawing from above. The upper cut should be made slightly farther back from the trunk than the under. This method overcomes splitting back. For removing large branches a pruning saw is desirable, of which there are a very great many forms on the market. The ax should never be used.

All branches should be cut off as near the branch or trunk to which they are attached as possible, and the cut should be made parallel to the part from which removed. While this makes a somewhat larger wound, it will heal more readily than a small wound made in any other way. Stubs are monuments to the ignorance of the pruner, unless one-year-old growth left for the production of fruit spurs. On older wood they are valueless, seldom heal over, and become sources of infection and decay.

Care should be taken to have the surface of the wound smooth. Rough or splintered wounds heal slowly and the longer the time required in healing, the greater the danger from infection. If the bark has been torn around the edges of the wound, the uneven edges should be cut back to sound bark. Sharp tools are necessary for good work. The knife, pruning shears, and saw usually make good wounds with ordinary care, but dull tools should always be avoided.

Wounds a half inch or more in diameter should be treated—those which are smaller heal so readily that it is unnecessary. Any material that is adhesive will prevent checking, keep out moisture and fungi, and will not injure the cambium, may be used. The object of treating the wound is protection, thus insuring good healing. The material used will not hasten the healing only as it prevents unfavorable conditions. One of the best, cheapest, and most easily applied materials is white lead. It should be quite thick so as to give a heavy coat when applied. Other materials frequently used are grafting wax and pine tar. The former is expensive, and does not adhere as well as lead; the latter rather disagreeable as well as expensive.—(Wis. E. S. B. 207.)

Treatment of Hollow Trunks.—It sometimes happens that a valuable shade or orchard tree becomes injured in such a way as to cause a cavity. This may have resulted from the breaking of a branch in a storm or from improper pruning. Whatever the cause the treatment is practically the same. All decayed or decaying matter should be removed from the cavity and with a sharp gouge or chisel all diseased wood cut away until sound heartwood is exposed. Then, before moisture or other injurious influences can act upon the newly exposed parts, the whole cavity should be filled with a thin mortar, made by mixing 1 part of Portland cement with 3 parts of clean, sharp sand. After the mortar has had time to become stiff, but not hard, a surface coat made of 1 part of sand and 1 part of cement should be added and the surface so faced as to exclude all moisture from the opening of the cavity. An additional safeguard would be had in treating the inside of the cavity with a copper-sulphate solution (1 pound to 5 or 6 gallons of water) after the diseased wood has been removed with a gouge or chisel and before the cement mortar is poured into the cavity.

Pruning Devices in Common Use.—Since the operation of pruning involves the making of wounds and ready healing depends upon a smooth, uniformly cut surface, the selection of pruning tools is important. It is obvious that a tool which operates in the manner of a knife will leave such a surface as is desired; but it is not always possible, in pruning large trees, to use a simple knife. Where a knife will serve the purpose, as in the pruning of shrubs and small trees, the hawkbill knife will be found most satisfactory. Where larger branches are to be removed, the hand-pruning shears, which consist of a strongly made shear which is opened by a spring, and the blade made of well-tempered steel and provided on the opposite side with a guard are the most convenient device. Where still larger branches, which can be removed without a saw, are to be pruned, the lopping shears can be most successfully and economically used. The one objection to both these forms of shears is that the cutting is done by a sort of crushing process, one side of the shear alone being provided with a cutting edge, the other being merely a rest or guard. Another type of shears has been designed but never put into general use which, instead of cutting by a simple crushing movement, cuts by a drawing movement, the blade being arranged on a sliding joint which provides for the drawing motion of a knife as the shears close.

Shears for Pruning Hedges.—For the care of hedges, both deciduous and evergreen, the ordinary hedge shears, consisting of long straight blades with comparatively short handles, which are grasped in either hand, are most satisfactory.

For High Branches.—Where the pruning required consists of the removal of small branches high up in the trees, which can not be done by the operator standing upon the ground and which would necessitate the use of a ladder, the shears have been modified so as to be attached to a pole which enables an operator standing upon the ground to remove branches several feet above his head. These shears are subject to the same objection as those previously described, that they cut by a crushing process, but nevertheless they are exceedingly useful and economical for the removal of water sprouts and for cutting back leading shoots in tall trees.

Pruning Saws.—Where the removal of large branches becomes necessary, a saw must be substituted for the knife or the shears. In such cases it is frequently desirable that the saw be so constructed that it will cut with a drawing motion rather than when pushed from the operator. There is a saw upon the market which combines both features, that of cutting on the downward stroke and on the upward stroke, one edge of the saw being provided with teeth for each motion. The blade of the saw is also curved, which enables one to reach some distance above his head and by drawing the saw toward him have it cut very freely on the downward stroke, which it would not do were it straight or provided with teeth set in the opposite direction. This type is exceedingly useful where the removal of branches of considerable size is necessary. Other forms of pruning saws are made to be used upon the end of a pole, and some are also provided with a chisel blade at one end so that they can be used for smoothing the cut surface after sawing off a branch, or for cutting off small water sprouts or branches in the same way that they would be cut with a hatchet. This method of removing branches, however, is not to be commended, as it is seldom possible to cut them close to their origin, which is, of course, necessary in order to secure the best results.

Pruning the Apple.—In pruning a fruit-bearing plant like the apple, attention must be given not only to the height and formation of the head, but to the removal of wood as well. The apple bears its fruit on spurs which are themselves developed from wood one year or more of age. For that reason, therefore, the removal of wood which carries fruit spurs reduces the crop the tree is capable of bearing. This then, is a practicable way of thinning the fruit. Besides accomplishing this result pruning can be used to lessen the annual growth and force the energy of the plant which would naturally be used in making wood into the fruit, thus increasing its size or enabling the tree to carry a larger quantity than would be possible were a normal wood growth permitted.

Forming the Head.—Modern orchardists have come to look upon the low-headed tree as more desirable than those headed high.

A head which is 2½ to 3 feet from the ground is at present considered more desirable than one which is 6 feet or more from the ground. The latter height was formerly frequently used. In forming the head care should be taken to have the framework branches disposed at different heights along the body of the tree—say from 3 to 6 inches apart, and distributed as evenly as possible around the body as a central axis; that is, when viewed from above the picture presented would be that of a wheel, the hub being the central axis of the tree and the framework branches representing the spokes.

Main Branches.—For an apple tree three branches are considered the ideal number. More may be left upon some varieties, particularly those which are strong growers and upon trees which have a well-developed root system at planting time. If, however, the roots have been badly mutilated in removing the tree from the nursery, it will be safer to reduce the number to three rather than to maintain a larger number. These three main framework branches upon the ordinary first-class nursery tree should not be more than 10 or 12 inches in length. At the close of the first season's growth after planting each one of these three framework branches should be considered as though it were a separate nursery tree and, if possible, three subdivisions of this should be maintained for the wood supply of the second year, the three branches retained being cut back to about the same length as those originally held by the tree as planted in the first place. This operation should be repeated each succeeding year. By so doing a symmetrical development can be maintained, and by cutting to an outside or an inside bud the habit of the tree can be modified so as to make it upright or spreading in character. Some trees are normally upright in their habit of growth, while others are spreading. This must be borne in mind and the character of the variety under treatment must be taken into consideration in cutting the branches, so that they will be upright or spreading according to the desire of the planter.

Effect of Cutting Back.—This frequent cutting back of the branches of the tree while it is young prevents the long, bare branches which are so characteristic of old orchard trees. It also prevents the tree from growing too tall—a condition which makes it difficult to gather the fruit or to spray the tree. With the low-headed trees less propping is necessary than with trees having long framework branches. The load of fruit is carried nearer the trunk, and the main structural branches being larger in proportion to their length are therefore better able to carry any load of fruit which the tree may develop.

Annual and Biennial Crops.—Judicious pruning, as has been pointed out, not only facilitates the work of cultivation and spraying, but at the same time determines to a very considerable extent the fruiting habits of the tree; that is, the quantity of bearing wood which a tree carries can be modified by pruning so that it will be practically impossible for the tree to retain more fruits in any given season than the root is capable of supplying with a proper amount of nourishment. With such a balance between the fruit-bearing wood of the tree and its root system maintained, biennial crops will be less likely and annual crops will be more common. Orchardists in general are coming to believe that the reason for the biennial crop in many orchards is due to the fact that during the crop year the trees are allowed to overbear and that their vitality is therefore so much reduced that it is impossible for them to carry a satisfactory crop the succeeding year. The thinning of the fruit, with the result that a crop is borne each year, has convinced practical growers that overbearing is the cause of the biennial fruit production.

Pruning the Pear.—What has been said of the apple applies equally well to the pear; but, since pears are grown both as standards and dwarfs in commercial orchards, a consideration of the pruning of both classes is necessary.

Forming the Head.—A low-headed pear tree is quite as desirable as a low-headed apple tree. In forming the head of the pear, however, more branches may be left than in the case of the apple. While three is given as the ideal number for the apple, as many as four or five may be retained by a well-grown pear tree. These should be distributed about the body so as to give practically an equal space between them, and, if possible, they should stand at different heights upon the main stem. The number of branches to be left upon any particular tree must, however, be determined by the condition of the root. If much root has been lost, a smaller number of branches should be retained, and those retained should be shorter than in the case of a well-developed root. In general, however, the three, four, or five branches left upon the young pear tree should be shortened to about 10 or 12 inches in length. Each of these should, at the close of the first season, be treated as though it were a separate plant, and the number of shoots which it has developed be reduced to either two or three, and these in turn shortened to at least 12 inches in length. This operation should be repeated from year to year until the tree comes into full bearing, when less shortening will be required. In fact, as the tree grows older it will be found that, instead of retaining the original length of the annual shoots, they will reduce themselves in many cases to 6 or 8 inches in length. This is due to the fact that the energy of the root is distributed through a large number of branches, rather than to a few. By adhering to this system of pruning a symmetrical, broad-headed tree can be secured, and as fruit bearing increases the framework branches will tend to become more and more drooping.

Control of Blight.—In addition to modifying the form of a tree by pruning, another and equally as important a factor can be controlled by this means. As is well known the pear ordinarily suffers severely from the pear-blight, but the work of Mr. M. B. Waite, of the U. S. Department of Agriculture, upon this disease has fully demonstrated the possibility of controlling it by judicious methods of pruning.

The pear-blight gains entrance to the tree in a majority of cases through the flowers, and as the flowers are borne upon spurs, and as these spurs are developed from wood which is one or more years of age, fruiting spurs frequently appear upon the pear on large branches. It therefore becomes evident that if these fruiting spurs are allowed to remain upon the large structural branches of the tree, and the blossoms of such a spur become affected by the pear-blight, the blight will immediately become communicated to the framework branch upon which the spur is situated. In consequence, a case of what is called "body blight" results. It is evident, therefore, that if the fruiting spurs which bear these blossoms are kept off the large branches of the tree there is less liability of injury to them from the blight. Persons engaged in pear culture should, therefore, pay the strictest attention to the removal of all fruiting spurs from the main structural branches of the pear tree. This will force the development of spurs upon the smaller branches, and as these can be allowed to develop at a considerable distance from the main body of the tree, contamination with the blight will only necessitate the removal of one of these smaller, minor branches, rather than the loss of a main framework branch. By systematically cutting out all blighted branches which appear among the fruit-bearing branches of a properly pruned pear tree, it will at once rid the tree of the blight, without any serious detriment to the tree itself. This is the principle underlying the control of the much-dreaded pear-blight, and, as before stated, it is controlled primarily by judicious pruning.

Pruning Dwarf Pears.—Dwarf pears are as a rule pruned as pyramids. For this reason the nursery trees are handled very differently from standards. Branches are allowed to grow close to the ground and a central axis clothed with branches from near the ground to its extremity is maintained rather than a bare trunk to the height at which the head is desired, as in the standard tree. In the pyramid these lateral branches are left longest near the ground and shortest near the apex of the pyramid. This method is adhered to from year to year in pruning the annual growth of the tree. The annual pruning of a pyramid is of even greater importance than in the case of the standard pear, for upon it depends the symmetrical development of the tree.

It is well known that orchard trees in general tend to make their greatest growth near the extremity of the leading branches. In other words, the leaders are the strongest growers and it is frequently a difficult task to stimulate lateral branches to grow sufficiently to preserve a symmetrical development in the tree. The manner, therefore, of cutting back the annual growth on the various parts of the tree must be carefully studied in order to preserve the symmetrical development desired. In removing the annual growth from pyramidal trees it should be the aim to cut back to an inside bud each year. This will tend to make the growth of the tree more upright and more compact, while with a vase-formed tree it should be the object to cut to an outside bud each year.

Pruning the Peach.—In general, the peach is a stronger and more rapid grower than the apple or the pear. For that reason it is planted in the orchard at an earlier age than either. Yearling peach trees are considered more satisfactory by orchardists than older trees.

These young plants are usually reduced to a single stem or whip at planting time, the head being formed from the shoots which develop along the body of the tree during the first year of its growth. It is an easy matter to go over the newly planted tree and rub off such shoots as are not desired.

Forming the Head.—Practically the same rule that holds for forming the head of the apple and the pear is adhered to in forming the body branches of the peach, three or four being the number most frequently used. These shoots are, at the close of the first season, shortened back to about 1 foot in length and are allowed to divide into three or four branches during the next season's growth. The same heading-back and multiplication of the branches takes place the next year. At planting time, however, the main stem of the tree, which carries the roots but no lateral branches, is seldom more than 2 feet in height, so that when the framework branches develop from it the head of the tree is not more than 18 or 20 inches from the ground. This arrangement enables workmen standing upon the ground to gather the fruit during the first three or four years of the fruit-bearing period. As the tree grows older and the branches become longer, it is necessary to employ picking stands of some description. The best growers, however, systematically shorten the annual growth of all of their orchard trees.

Freezing.—In the Southern States, where trees are not likely to be injured by freezing, this pruning can be done during the fall or early winter, but in the northern portions of the peach-growing area of the United States it is best to delay heading-in until all danger of winter killing is past. It frequently happens that the freezes are severe enough to reduce the annual growth as much as it is desirable to reduce it by pruning, and had the pruning been done before the freezing occurred there might have been an entire loss of the peach crop; but when pruning is delayed until all danger of freezing is past the pruning can be gauged so as to reduce the fruit-bearing wood in proportion to the capacity of the tree, for, as is well known, the peach bears its fruit upon wood of the last season's growth rather than upon fruit spurs, as in the case with the apple and pear. For this reason, therefore, the heading-back of peach trees plays an important part in thinning the crop.

Shape of the Tree.—Ordinarily it will be found most satisfactory to prune the peach so as to make a broad, round-headed tree rather than a pyramidal or vase-shaped tree. In certain localities the vase-shaped tree may be found the most desirable, but as the fruit is always borne on the outside or upon the new wood of the tree, it is in a position to receive full sunlight, and the open-headed vase-shaped form is therefore less desirable than in the case of fruits which are borne well inside the tree.

Pruning the Plum and the Cherry.—The habit of the plum to bear early and abundantly under favorable conditions limits its annual growth to such an extent that after the bearing age is attained little annual pruning is necessary other than to remove dead or interfering limbs or to head back an occasional strong shoot which may appear from time to time in the center of the crown. The plum, as well as the cherry, has the annoying habit of occasionally producing strong shoots from adventitious buds along the trunk of the tree or from near the surface of the ground. A close watch should be kept for such interlopers in order that they may be promptly removed.

Framework.—During the early years of the growth of both of these plants care should be exercised to secure a proper distribution of the limbs which are to form the framework branches of the tree, particularly with the Japan plums and the sweet cherries, as both these species have the unfortunate habit of dividing into two shoots of nearly equal size with a close angle between, which always forms a weak joint. Trees not carefully pruned to overcome this bad habit are liable to severe injury from splitting when heavily loaded with fruit.

Cutting Back.—In the early period of the growth of both the Japan and American plums, as well as the sweet cherry, the annual growth will need more or less severe cutting back, depending upon soil and climatic conditions, in order to maintain them within bounds. On general principles this heading should be done just before growth starts in the spring.

Form of Tree.—The European plums (*Prunus domestica*) do well when trained after the general fashion of the peach. In general however, the main trunk of the plum should be somewhat longer than that of the peach, in order that the work of jarring for the curculio may be facilitated if the orchard happens to be located where this operation is necessary.

Fruiting Habits.—The fruiting habits of the plum and the cherry are more closely allied to those of the apple and the pear than to the peach, and for that reason the shortening of the annual growth is of less moment with these plants than with the peach.

Pruning the Grape.—In no fruit crop does pruning play so important a part, both as regards the quantity of fruit borne and the cost of producing it, as with the grape. In fact the manner of pruning employed determines to a very large extent the cost of maintaining a vineyard. Certain styles of pruning require a large expenditure of money in the construction of supports or trellises and an equal outlay each season for tying, both early in the season and during the summer. Other systems require less expensive trellises, and little or no expenditure of time or money in spring and summer tying, thus making a very considerable difference in the cost of producing a good quantity of fruit and, since grapes have, during the last decade, become so cheap, the margin of profit left to the grower over and above the cost of production is very small, even when the most economical systems of training are employed.

Systems Used.—In this connection two of the important systems used by eastern grape growers will be described, namely, the Kniffen system, and the high-renewal system. The first named requires no greater outlay for trellises than does the second, but permits of growing the crop with very much less summer tying than is required by the high-renewal system.

The Kniffen System.—It will be noted that the long trunk employed in the Kniffen system carries the fruiting branches far above the ground. This permits the annual growth to fall from the supporting wires in a natural way without the necessity of tying. This constitutes the chief advantage of this system over any other employed in the eastern grape belt. Another slight advantage which the Kniffen system has over the high-renewal or the renewal system is that the fruits are farther from the ground and experience teaches are less liable to injury from mildew and rot. They are also somewhat easier to spray, although there is comparatively little difference in this regard between the Kniffen and the high-renewal systems.

The Kniffen system, then, consists in the carrying of either one or two main trunks to the height of 3 to 5 feet above the ground; sometimes they are carried to the height of 6 feet or more. If two trunks are employed, one is carried 6 feet or more above the ground and the other about 18 or 20 inches lower. It is not desirable to attempt to make the two stories on a single trunk, as the laws of growth induce development at the extremity of the cane and therefore the set of branches which is lowest upon a common trunk makes little or no development, growth being confined almost entirely to the uppermost set of branches. When two trunks are employed, however, the case is different and each set of branches becomes, as it were, terminal branches, and a much more satisfactory growth results.

The method of renewal employed in the Kniffen system is practically the same as that in the high-renewal system; that is, the canes which are to bear the fruit during the next season are selected from wood which developed the previous year. These canes are cut back to six or eight buds and are tied to the central wire of the overhead trellis. At the close of the season the bearing cane is removed and a new shoot, one developed from near the head of the trunk, is used to replace it during the succeeding year. The same treatment is employed for the other side of the head; that is, the T-head at the top of the trunk on the Kniffen-trained vine serves the same purpose as the T-head at the top of the trunk of the high-renewal vine.

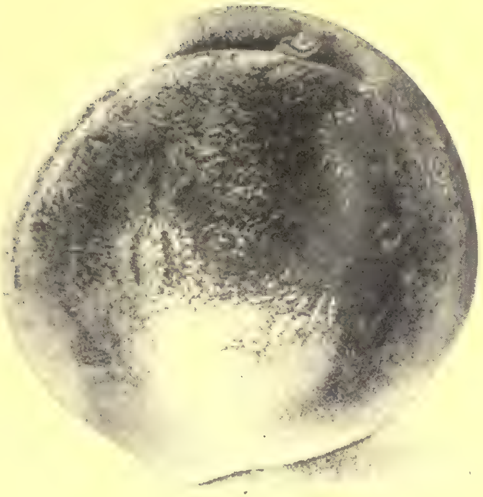
The High-Renewal System.—The high-renewal system of training requires a trellis consisting of three or more wires or other suitable supports carried by posts or stakes placed at convenient distances apart in the row of grapevines, the vines themselves being planted 8 or 10 feet apart in the row. The first or lowest wire upon the trellis is usually 18 or 20 inches from the ground. The next is about 18 inches higher, and the third about 2 feet still higher. The main trunk of the vine is carried to the height of the lowest wire or support. From it a cane carrying about eight buds is trained in either direction along the lowest wire. From each of these buds shoots develop which bear the crop of the season; but as these shoots are seldom able to care for themselves they must be tied to the upper supports of the trellis.

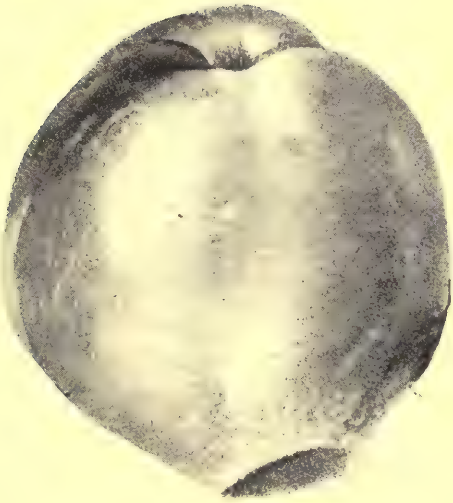
It will be noted from this that the summer tying of plants trained on this system is very much greater than with plants trained on the Kniffen system. From the T-head, which, as has been stated, is carried to the height of the lowest wire, canes are carried in both directions along the lowest wire and are firmly tied to it. Near the base of each of these canes, but upon the older wood of the T-head, short spurs carrying two or three buds are maintained, from which shoots develop which, in turn, are usually employed to furnish the fruiting canes of the succeeding year; that is, the spurs are the means of renewing the fruiting wood of the vine grown on the high-renewal system. The same plan can be and frequently is employed with the Kniffen system.

Pruning the Raspberry.—In many sections of the country the black raspberry as well as the red raspberry is extensively cultivated for commercial purposes and also for family use. When grown upon a commercial scale the plants are set in rows 6 or 8 feet apart and 3 feet apart in the row. With this style of planting and judicious pruning no trellis is necessary.

The First Step.—The usual plan is to allow the young shoots which annually spring up from the root of the plant to grow to the height of 2 feet or a little more. When the shoots have attained this height the first step in the pruning of the raspberry begins by breaking off 3 or 4 inches of the topmost portion of the shoot, leaving it 20 to 22 inches in height. The rapidly growing succulent shoots snap off easily between the thumb and finger, and as a rule no shears or other pruning device will be found necessary to accomplish this heading-in. As a result of the check sustained by breaking off the terminal bud, the stalk thickens, the leaves grow larger, the axillary buds near the end of the stalk increase in size, and soon lateral shoots develop from them. As a rule, five or six of the topmost buds push out and, instead of having one sturdy stalk several feet in length which would carry one-half dozen fruit clusters near its tip the succeeding season, pruning has restricted its height to 20 or 22 inches and has induced the formation of five or six lateral shoots, each of which may grow to be as much as 18 inches or more in length before the close of the season and, instead of a single cane for fruit production, there are five or six, each of which will carry as many fruit clusters as would have been produced by the original shoot had it been left to itself. Here, then, is an example of pruning inducing fruitfulness.

Removing Old Wood.—The second stage in pruning the raspberry consists in cutting out all the wood which is older than the present season's growth. This pruning should be done immediately after the season's crop has been harvested. If done at this period it is easy to distinguish the fruiting wood from that which has grown during the season, and by taking out all the useless wood at this time the whole energy of the root is reserved for the new growth which is to supply the crop next season. For cutting out this wood a special implement is employed. A cutting edge is provided on the hook which reduces it to a hawkbill knife, and as well upon the chisel-shaped portion upon the back. In one case the implement serves the pur-




D G. Passmore.

Influence of Precooling on Peaches

[Fig. 1.—Hard ripe Early Crawford peach delivered at New York in sound condition by precooling and ordinary icing. Fig. 2.—Early Crawford peach from California, picked green and shipped to New York under ordinary icing in the usual way.]

pose of a brush hook on a small scale and in the other, when the chisel blade is used, it serves as a spud.

Lateral Branches.—A third step in the pruning of the raspberry is shortening the lateral branches which have developed from the headed-in shoot. This work is usually done in the spring before or at blooming time, and is for the purpose of regulating the crop as well as reducing the wood so as to enable the cane more easily to support the fruit and to make the work of harvesting more easy.

New Growth from Roots.—From what has been stated it will have been inferred that the raspberry bears its fruit most abundantly upon wood 1 year of age, and that older wood is of little or no use and should be cut out for the good of the plant. There are exceptions to the rule, for raspberries frequently bear a few fruits upon the new shoots which annually come up from the root of the plant when those shoots are allowed to grow unchecked; but as this forms a late or second crop, and as it does not occur as a fixed habit of the plant but rather as a result of peculiar weather conditions, it is never taken into account in commercial raspberry culture.

Results of Pruning.—The shortening of the shoots to 2 feet or less in height, together with the thickening which follows, renders them able to support a crop of fruit without the aid of a trellis.

Pruning the Blackberry.—In general, the pruning of the blackberry is the same as that of the raspberry and, except to stop the annual growth higher than the raspberry, no modification of the directions given under that head need be made.

Pruning Currants and Gooseberries.—If ease of cultivation were the only consideration in pruning currants and gooseberries, the tree form would certainly be most convenient and economical. Unfortunately the grower has no choice in this matter, for in order to insure his plants against the ravages of borers of the root and stalk it is necessary to train both these plants in a bush form. When managed in this way new wood can annually be induced to spring up from the root to replace any canes which may be destroyed by borers or which may for any other cause become useless to the plant. The new growth should be stopped when it reaches a convenient height, in order to induce the formation of side branches and thus increase the area of bearing wood. This is much more important than would at first appear, because the fruit of these plants is borne upon fruiting spurs which develop from wood two or more years of age. On the other hand, the renewal of the bush is not only necessary in order to maintain it against insect pests, but to insure a supply of fruit bearing wood to take the place of the old wood which it has become unprofitable to maintain.

In general a currant bush should be composed of from five to eight stalks, stopped about 18 to 20 inches in height. If the plants are vigorous, shoots stopped at this height will produce several lateral branches, thus forming a compact, broad-headed bush with a maximum expanse of bearing wood.

Gooseberries.—The gooseberry should be treated in like fashion, but will be found to require less heading-back, because its normal habit is to produce numerous side shoots rather than strong, upright ones.—(F. B. 181.)

PRUNING SUMMARY.

(*a*) Trees may be left until after they are set out before pruning except that they may sometimes, with advantage, be pruned at the nursery to save freight.

(*b*) Severe pruning is often needed for young trees, since much depends upon the proper forming of the head of the tree at this time.

(*c*) No pruning point is more important than that of deciding at what height the trees shall branch out. This will depend very much on location.

(*d*) In New England, where the climate is comparatively cool, trees with long trunks are in favor as tending to facilitate cultivation. In the Middle and Pacific Coast States the best results have come from allowing the branches to start within 2 feet or even closer to the ground and thus the trunk is protected against sunscald.

In orchard practice trees are pruned—

(*a*) To remove all dead or decaying branches or branches which rub against each other.

(*b*) To shorten the annual growth for the purpose of making the tree more compact, better able to carry a load of fruit without breaking, more easy to cultivate, spray, and harvest the fruit.

(*c*) As a means of thinning fruit to secure increased size and quality.

(*d*) To rejuvenate old or weak trees.

(*e*) To control certain diseases, like pear blight.

(*f*) To make the trees more shapely or to train them into some special form.

Trees are sometimes root-pruned to check a too rank, vigorous wood growth, and thus throw them into bearing. Ringing a branch or trunk has a like effect. It is most frequently practiced with grapes to secure a larger earlier fruit.

Some of the more essential points to be remembered in pruning are:

(*a*) To cut all large branches close to the trunk from which they spring and parallel with it. Where only the annual growth is removed the cut should be immediately above a bud.

(*b*) To prevent decay the cut should be made smooth and painted with some such material as lead paint, grafting wax, etc.

(*c*) To prevent splitting of the trunk the branches should be trained out at different heights around the trunk and acute crotches avoided.

(*d*) Severe top pruning has a stimulating effect, resulting in a vigorous growth of new shoots and is most useful in rejuvenating an old orchard.

(*e*) Severely winter-injured trees should be only mildly pruned. If the fruit buds only are killed the pruning may be more severe.

(*f*) Wounds heal over best if the pruning is done during the growing season, but for convenience sake and also to prevent bleeding in the case of grapes, it is generally done in early spring before the growth starts in the tree.

Pinching or disbudding is a modified form of pruning and relates to the removal of buds. By removing the terminal bud of a branch the development of lateral buds and shoots is encouraged. Pinching is most commonly practiced with raspberries.—(U. S. E. S. B. 178.)

ORCHARD PROTECTION.

Throughout the whole life of fruit plants there is danger of injury from a variety of causes. Among the more common of these may be mentioned sunscald; winterkilling of the twigs and roots; winterkilling of the fruit buds; sleet storms; injuries from birds and live stock, from wind, rain, and frost in the growing season; girdling by mice and rabbits; and injury from label wires, insects, and diseases.

Sunscald.—This is the name given to a condition of the bark of trees which is probably the result of exposure to the sun under peculiar conditions. Its effect is usually to injure the bark on the south and southwest sides of the tree which later peels off, leaving the wood exposed. This soon begins to decay and permanent injury results. It has been found that shading the trunk will prevent this injury, hence a common remedy is to cover the trunk with burlap, cornstalks, or similar material, especially during the time when not protected by leaves. The growing of branches on the south side of the tree so as to shade the trunk from the sun and the inclining of the trees toward the southwest are also effective remedies.

This injury is most liable to occur during severe droughts and in the early spring or late winter before growth has fairly begun. It is supposed to be caused by the warm sun of the middle of the day starting active life in the portion of the trunk exposed to its direct rays. Later, when a cold spell comes, the soluble compounds formed by the renewal of active life are decomposed and the protoplasm is destroyed. The trees most liable to this injury are those that are newly set and weak; such as have smooth bark, as hard maple and basswood; also trees with trunks inclining to the northeast and those on dry land.

It is well known that one portion of a dormant plant may start into growth independently of the condition of the rest of the plant. Thus a branch from a grapevine or other plant brought through an opening into a greenhouse in winter will soon start into growth while the rest of the vine out of doors is frozen. In like manner the portion of the trunk of an apple tree that is exposed to the direct rays of midday sun may start into growth independently of the rest of the tree.

Winterkilling.—This may be confined to the twigs and flower buds of fruit trees. Injury from this cause is most liable to occur in valleys. On the adjacent higher land there may be comparative immunity. Frosts are most likely to do injury in places where the air is stagnant, especially in low spots where the air is not affected by light winds and into which the cold air from the surrounding elevations drains. Such places are indicated when the first severe autumn frosts occur, particularly if the night be calm. The dense cold air flowing into the lowlands fills the hollows and cools vegetation to the temperature of frost. In such places winterkilling is frequently serious. A windbreak may also make a frost pocket even on a side hill by interfering with the free circulation of air.

In districts where injurious frosts occur, high elevations tipping to the north or east where vegetation is rather backward in the spring afford the best locations for fruit growing. Other locations comparatively exempt from injurious frosts are such as are near lakes or large streams, which tend to produce an equable climate.—(U. S. E. S. B. 178.)

Effect of Frost on Fruit Crops.—The fruit grower, from time immemorial, has been at the mercy of the elements. Frost is one of the most formidable foes with which he has to contend. Millions of dollars are lost annually by silent, relentless frosts that come either when the trees are in blossom or just after the fruit has set. Recent demonstrations in the fruit district of the Middle West have proved beyond a peradventure that damage to fruit trees by frost can be controlled to a greater or less extent. One of the fundamental principles that underlie successful frost fighting is a knowledge of the subject of air drainage. Cold air, like water, settles to the lowest ground, and anything that will break up this stratum of cold air and cause it to mix with the upper strata of warm air will prove of great value in combating frost injury. Frost injury to fruit trees most frequently occurs when there is a clear, still, dry atmosphere, and when the radiation is uninterrupted by clouds or moisture, and the cold air settles in poorly air-drained areas. While frosts may not be severe, they are often just severe enough to damage the blossoms and tender fruits, and they not only reduce a crop of fruit one-third to one-half of what it should be, but sometimes destroy the entire crop for one year or for several successive years.—(Y. B. 1909.)

Orchard Heating.—In orchard heating the fuel to be depended upon must be easy to light, a fuel that will burn a long time and that will give out a great amount of heat; it must also be easily controlled in regard to temperature. Oil, in some form, doubtless best meets these requirements, but where oil is scarce and coal abundant the latter would be the cheaper fuel.

The oil heater, so far as we know, was first manufactured by a firm in Fresno, Cal. Since then several styles of oil heaters have been manufactured and put on the market. One of these well-known and extensively used orchard oil heaters, constructed on scientific principles, has a center-draft tube that feeds oil to the flames, promotes combustion, and makes good use of the oil. The heater holds about 5 quarts of oil, will burn six or seven hours, is made of 28-gauge iron, and weighs, with cover, 1¾ pounds. It stands 11 inches high. The heaters nest nicely, fitting one into the other, for shipping purposes. The cover is made to fit like a lard-pail lid, and is raised in the center so as to shed water. This heater has successfully stood the test of several years. It is successful because based on the principle that there is no need for great heat locally, but for numerous small fires well distributed. The small fires do not necessarily change the direction of the air draft, the object being to warm up the draft as it is pressed down from above by the settling of the colder air, and thus avoid the forming of cold spots or pools. Above the danger point the upper air strata are warmer, and usually a few degrees of rise in temperature is all that is necessary for safety. An oil heater is so arranged that the heat may be increased or diminished at will. There are larger heaters that hold 6 gallons of oil and burn thirty-five hours, but the medium size is deemed best for all practical purposes.

An oil heater can be more easily and quickly filled and lighted than a coal heater. Crude oil has been furnished in tank lots at about 4½ cents a gallon and it makes a quick and excellent fire and an intense heat. It is a fuel that will require little or no attention after lighting, but gas oil is considered far better. By using oil one man can care for 3 to 5 acres for four hours, and this is about as long as it is customary to use a heater at any one time. One hundred oil heaters are used to the acre and they can be made to raise the temperature from 10 to 15 degrees. These heaters range in price from 15 to 25 cents apiece. The fire can be easily extinguished; the heater is perfectly adjustable and can be closed so that 4 quarts of oil will burn twenty-four hours, or the oil can burn like a bonfire and be consumed in two hours.

Heaters may not be necessary, but if needed will be needed very badly and very quickly. Any one who has 10 acres of orchard located in the frost belt can afford to use a carload of oil. This oil may be stored in the orchard in iron tanks or in cisterns made of cement. The tanks cost about $75 each and the oil may be saved from year to year if not used. Crude oil has its objections. A disagreeable, greasy soot is produced by it which settles on trees, buildings, outbuildings, and even on the inside of buildings.

Prevention of Frost Injury Possible.—From the abundance of testimony already obtained from reliable sources in various parts of the country, it is safe to say that the prevention of frost injury to fruit crops has passed the experimental stage and has become a well-established fact that can not be controverted or lightly passed by.

Many thrilling frost fights have occurred in Colorado. In 1908 two men saved large crops on the heated half of their places and lost them on the half not heated. This was a practical object lesson to fruit growers, who as soon as they saw what had been done investigated the matter thoroughly, and the growers at Canyon City appointed an orchard-heating committee, the first in existence. With $1,000 at their disposal they zealously made experiments to determine just what could be expected in the way of raising the temperature and what the cost would be. For six months these experiments were tried with every sort of fuel and the various market devices for burning it. After an extensive investigation the committee unanimously recommended oil as fuel, it being as cheap as any other and the fires more easily obtainable. It is said that in 1909 there were orchard heaters in every fruit section in Colorado, and in some sections 80 per cent of the orchards were equipped. The statement following was made by a member of the committee.

The spring of 1909 was severe, proving to be one of the worst in the history of the State, and had lack of protection been as formerly, little, if any, fruit would have been shipped from Colorado. As it is, one of the largest crops in the history of the State will be gathered, and it is estimated that $4,000,000 was saved by orchard heaters to the fruit interests of the State.

The experiments of the orchard-heating committee (which tests are a matter of record) showed that the temperature could be raised 14 degrees on a still night with 100 pots to the acre. The experiments this past spring in time of actual danger fully substantiated the claims made by the committee.

The last night of April, 1909, the thermometer in the Canyon City district fell to 17° above zero. The orchardists with oil heaters kept the temperature up to 28 or 30 degrees, or what they considered the safety point. On the preceding night there was a terrible blizzard; the wind blew a gale and there was over 8 inches of snow, which kept the oil from burning as freely as it otherwise would, but in spite of these awful conditions the temperature was raised from 21 degrees, where it remained for over five hours, up to the safety point.

As an experiment several acres were left unprotected by heaters, heating the balance of the orchard. There is a banner crop on the heated orchard, probably more than 15,000 boxes; while on the several acres not heated, on which are 100 trees 10 years old in full bearing of late winter varieties, there will not be a box of apples. One who has never realized the relief of saving the crop can not understand the feeling. In times past Colorado growers have gone to bed knowing they would be practically ruined before morning should break, and feeling absolutely helpless to do anything to protect themselves. This year the aspect is very different; the towns and surrounding country were perfect beehives of activity, and as soon as the danger signal sounded thousands of volunteers hurried to help the orchard men, and for hours the battle waged, never slacking until the great foe was vanquished.

In this orchard district of Colorado an exceptionally large crop of fruit was marketed from the orchards where the heaters were used. The same experiment has also been tried in New Mexico, where results were equally successful. One man reports a case in the Pecos Valley where 2,600 oil burning heaters of 1-gallon capacity were used on a 30-acre orchard with the result that a full crop of fruit was saved and sold for $26,000, while in the rest of the valley the apple crop was almost a complete failure. Successful frost fighting is comparatively new. It is necessary to have a force of men, industrious, careful, painstaking, and observing to the last degree. Unless the work is properly done it had better not be done at all. As stated, the worst damage may be expected in April or during the blossoming period and the time when the fruit has set. Any temperature lower than 28° F. is likely to destroy a crop. The margin, in degrees, between danger and safety is usually small, the thermometer at such times varying for a few hours at a time from 28° to 20° F. The temperature can be raised by the oil pots at least 12 to 14 degrees.

The necessity for being prepared for frost fighting can not be too strongly urged upon orchardists. Changes in the weather are sudden and often the unexpected happens. A balmy spring morning with a southerly wind and an April shower will cause the fruit buds to burst forth prematurely; then suddenly the wind changes to the north or northwest, the clouds disperse, and a clear, cloudless night follows, when a dangerous frost will probably occur and do much damage unless the orchardist is prepared to save the crop by raising the temperature above the danger point. The freezing of the blossoms is likely to occur in the early hours before sunrise, a time when the temperature usually reaches the lowest mark. To guard against such emergencies everything should be provided for weeks in advance.

Thermometers should be placed in the orchard at convenient distances apart in order to maintain a uniform system of temperature readings, and a thermometer should also be located in an accessible spot near the house, where it may be readily seen at all times. It should not, however, be placed on the house, as the heat from the building will modify the temperature several degrees. A device for sounding an alarm of approaching danger which is said to be in use by some orchardists consists of a specially constructed thermometer connected by wire with an electric bell located in the house. When the mercury drops to near the freezing point the bell sounds the alarm in time to arouse the inmates for immediate action. One of these thermometers, or thermostats, costs about $20. Another electric appliance that has been used in California is the orchard heater lighter. The heaters are placed at uniform distances apart in the orchard, as previously stated, about 100 heaters to the acre. By a system of electric wiring and by means of a spark plug it is possible to light every oil heater simultaneously and almost instantly. In the areas which are visited by killing frosts this method of insuring against possible injury is a necessity, for if the apparatus is needed it is usually at some unexpected time and it is then needed very promptly. The saving of a single crop more than compensates for the expenditure for apparatus many times over.

A rapid lighter for lighting smudge pots is a recent invention, costing about $4. It consists of a can holding about five quarts, made of heavy enameled tin, the tubes, ratchet, lever, and valves being made of brass. One gallon of liquid, consisting of half kerosene and half gasoline, or all gasoline, is put into the can. The can is carried in the left hand and a torch in the right. The torch can be so arranged as to knock or pull off the cover of the previously filled oil pot; then with the index finger of the left hand the spring-acting lever on top of the gasoline can is moved over the smudge oil pot and instantly there drops a small teaspoonful of gasoline on top of the oil. The torch is immediately applied to the dropped gasoline, which ignites and starts the gas in the smudge oil. It requires so little time at each pot that it is hardly necessary to come to a full stop. One gallon of liquid is sufficient to light 800 smudge pots.

An orchardist does not hesitate to spend $400 for apparatus and material with which to spray his orchard in order to successfully fight insect pests and fungous disease. The necessary apparatus for successful frost fighting is neither complicated nor costly and should be kept on hand, provided the grower's orchard is in the frost belt.

The Weather Bureau publishes a series of maximum and minimum temperatures for the various sections of the United States; it also publishes the dates of probable killing frosts, for both spring and fall, for the frost-belt districts, and in addition to this its forecasters are able to send out a warning of probable frost injury about ten to sixteen hours before frost is likely to occur.

While orchard heating is comparatively new and the system needs to be perfected in some of its minor details, many thousands of dollars can be saved annually by properly protecting the orchards from frost injury by the use of artificial heat.—(Y. B. 1909.)

Winter Injury to Twigs and Trunks.—This is commonly due to the use of varieties too tender for the locality. The most successful remedy is to secure hardier sorts. When this is not possible, or the varieties grown may be particularly profitable, the trunk is protected in winter. In northern Minnesota the best authorities recommend that the trunks of young apple trees be surrounded with a box 6 inches square reaching to the branches and filled with soil to furnish protection against winter injury. They have discovered that even if the smaller branches are seriously injured by the winter, they stand a good chance of recovering, provided the trunk is uninjured. This protection also prevents sunscald, injuries from mice and from cultivation. In Florida some orange growers protect their tree trunks by piling the soil about them as far up as the branches.

Injury to the Buds of Fruit Trees.—This is a common source of loss to growers of cherries and peaches at the North. The fruit buds of these trees are liable to start slightly in warm winter days, and to be killed by the following low temperature, although the leaf buds may not be injured. Various remedies have been prescribed for this, among the most successful where the trees are small, bending them over in autumn and covering with cornstalks. The tops sometimes are tied together and covered with cornstalks or matting. Experiments have also been made in covering the trees with various paint compounds for the purpose of giving an extra covering to the buds, but without good results. One of the most ingenious ways of furnishing protection to peach buds has been tried by Professor Whitten, of the Missouri Experiment Station, who applied the principle that dark colors absorb more heat than light ones. He discovered that light-colored peach twigs were slower starting into growth than those that are dark, and conceived the idea of spraying peach trees with lime wash. He claims to have been very successful in this practice.—(U. S. E. S. B. 178.)

Laying Down Peach Trees for Protection of Buds.—The area of successful culture of the peach can be greatly extended if a practical means of protection against severe winter cold and late spring frost can be found. The Colorado Station has recently called attention to the successful employment in that State of the method of laying down and covering peach trees in winter. The method as practiced in Colorado apparently does not differ essentially from that tested at the Massachusetts Experiment Station as early as 1886 and during succeeding years except that in the Colorado method irrigation water is used to soften the soil so that the trees may be laid over without any special training or pruning of the roots. This is the Colorado method.—(Col. E. S. Bul. 80; Mass. (Hatch) E. S. B. 10, 17.)

Yearling trees are set in the spring and they should be laid down the first winter, repeating the process each season during the life of the tree. In this instance no attention is given to training or placing the roots. As soon as the trees have shed their leaves and the wood is well ripened they are ready for winter quarters. . . . The first step in the operation consists in removing the earth from a circle about 4 feet in diameter around the tree. When sufficient trees have been treated in this manner to make the work progress advantageously, water is turned into the hollows. After the ground has become saturated the trees are worked back and forth and the water follows the roots, loosening the soil around them so that they are pushed over in the direction that offers the least resistance. When treated in this manner the trees go over easily and with comparatively little injury to the root system—that is, providing the trees have been laid down each year. It is difficult to handle old trees in this manner that have never been laid down, and usually it will not pay to try.

After the trees are on the ground further work should be delayed until the ground has dried sufficiently to admit of ease in walking, and in the handling of the dirt. The limbs may now be brought together with a cord, and so lessen the work of covering. After experimenting with many kinds of coverings, burlap held in place with earth has proved the most satisfactory. The burlap is spread out over the prostrate tree top, taking special pains to protect the blossom buds from coming in direct contact with the earth covering. A light layer of earth is now thrown over the tree and the protection is complete.

The critical time in growing peaches by this method is in the spring when growing weather begins. Close watch must be kept to see that the blossoms do not open prematurely, or that the branch buds are not forced into tender, white growth. When the blossoms begin to open, the covering should be loosened so as to admit light and air, but it should not all be removed. More of the covering should be removed as the weather gets warmer, but the blossoms must be exposed to the sun gradually. Air and light are, of course, necessary for proper fertilization of the flowers, but after this process is complete and the fruit is set, all danger from the weather is considered as being over. The trees are usually raised about the middle of May at Canyon City. Raising the trees is, of course, a simple task.

The ground is again watered and when wet enough the trees are raised. To be sure, trees that have been treated in this manner will not usually stand upright unsupported. Consequently, they are propped up at an angle—usually two props being required to keep the wind from swaying them.

Professor Maynard found that when the trees were covered too closely with soil the buds were killed by heating, but when covered with mats and other light materials a large percentage of the buds were preserved. In some comparative tests made by him about 50 per cent of the buds of unprotected trees were destroyed while only 10 per cent of those of protected trees were killed. Many of the trees used in Professor Maynard's experiments were more than ten years old.—(F. B. 186.)

Winter Protection of Small Fruits.—Where winters are severe enough once in four years to seriously injure unprotected bush fruits, mulching or laying down will often pay well. Much depends upon the character and cost of the material used, and its durability. Straw, unless clean thrashed and free from grass seeds, is a most productive source of future trouble to the grower. Forest leaves can be secured in sufficient quantity in some localities to be available for use among the bush fruits. Where obtainable, pine needles also form an admirable mulch, and with a little care in removing can be used two or three times. Broken cornstalks that have been well tramped over in the barnyard are useful, and sorghum bagasse is utilized in some sections. In the colder and drier climate of the Upper Mississippi Valley the only sure protection for blackberries and raspberries is the laying down and covering of the canes. This is accomplished by digging away from one side of the plant, toppling it over with a fork, and wholly or partially covering the canes with earth from between the rows. This method involves staking or trellising the bushes when they are raised again in spring, but it is found profitable because of the insurance against crop failure which it affords. On most heavy soils water furrows should be run between the rows with a light one-horse plow late in fall, in order that surface water may be promptly removed during the winter months.—(1905 Reissue Y. B. 1895.)

Injury to Roots.—This may result from the use of a root stock too tender for the section in which the tree is grown. In Iowa, North Dakota, South Dakota, and Minnesota the best root to use for the plum is the *Prunus americana,* but when these are scarce the nurserymen use the Mariana, Myrobalan, and even the peach for stocks. The plum takes well on these last-named stocks, and they are commonly used in mild climates, but with such roots trees are often injured or killed out entirely by the severe winters of the extreme north. It is important, therefore, to have fruit trees on hardy roots in order to prevent winterkilling. Heavy mulching about trees that are on tender roots will often secure them against winter injury. Deep planting brings the roots where they are not injured, and the scion above, if of hardy stock, will generally send out roots correspondingly hardy. If, however, the scion has rooted, and the lower tender stock is injured by freezing, the effect is a weakened growth until a new root system has formed.

Other Injuries.—In remote sections deer browse the twigs of fruit trees and break them down. Farm stock is frequently injurious in the same way. Reasonable precautions will prevent this. Cattle are usually more injurious than hogs in the orchard. Wind often causes much damage to trees heavily laden with fruit by shaking it off and breaking the branches. The remedies are the use of wind-breaks and the supporting of branches by stakes or by tying one limb to another on the opposite side of the tree. Young trees in exposed situations are often injured by being blown about. This is particularly true in the case of trees that are newly set, especially those that have been set out in autumn. During the spring when the ground is soft the tree is easily loosened and killed. Autumn-set trees should always be staked if they are large enough to catch the wind. A pile of soil about a foot high around them will often protect them. In staking, the method of tying the tree so that it will not be scraped by the stake is very important. It would be better not to use stakes at all than not to secure the tree properly to them. Certain birds are often very destructive to cherries, raspberries, and similar fruits. As a rule the birds that commit these depredations are very helpful in destroying large numbers of injurious insects, and the toll they take in fruit is not more than they are justly entitled to. The "sap sucker" (*Sphyrapicus varius*), on the other hand, often girdles the trunks and larger branches of our choicest trees, and in this way does much injury. Yet the woodpeckers as a class are exceedingly beneficial, and even the "sap sucker" destroys great numbers of insects. Ruffled grouse sometimes eat the buds of fruit trees in winter, but they rarely or never cause loss to the farmer, since the quality of the fruit is improved by the process.—(U. S. E. S. B. 178.)

Protection of Fruit Trees from Rodents.—The soil or cinder mound as a protection against tree injury by field mice is first described, not only because it is quite effective in itself, but because it is recommended in conjunction with various other mechanical protectors designed to prevent injury by the larger rodents. Mice rarely injure trees except where grass, strawy manure, boards or trash of some kind about the base of the tree provide a hiding place; they will not come out into the open to work, but choose to perform their depredations under cover.

In mounding fruit trees for protection from mice there are three important points to observe: First, clear away the grass, trash or mulch from the base of the tree for a foot or more in all directions. Second, with the foot, or, better with a "post tamper," thoroughly firm the surface of the soil about the base of the tree. This breaks down and fills any runs or burrows that may be just below the surface. Third, with a few shovelfuls of fresh soil or cinders form a small mound (twelve or fourteen inches in diameter at the base and from 4 to 6 inches high) about the stem of the tree, firming the soil well.

The tops of these small mounds are usually kept quite bare by the sweeping force of the winter winds, even if there be several inches of snow on the ground. Mice will not venture out on these exposures to feed on the bark of the trees; and burrowing into the freshly packed soil is not likely to be attempted in the winter, even in open weather.

The mounds may be left throughout the year, but they should be tamped hard and repaired by the addition of fresh soil each autumn.

Where cinders are available these are a most excellent and inexpensive material with which to mound the stems of all kinds of fruit trees. Mice will not burrow through the cinders as they do through soil.

The Wire Screen.—This is the ideal and complete, all-round protector and it is, therefore, given first place among the mechanical forms. True, it is more expensive than many others, but it is lasting and thoroughly effective against all kinds of rodents which prey upon the stems of young trees. Being so light and open, it presents the least obstruction to strong winds; the air and sunshine are freely admitted; no dark and secure places of concealment, such as invite woolly-aphis and other forms of insect life are afforded.

This protector is made of galvanized wire cloth of one-quarter inch mesh (four 22 gauge wires to the inch) which may be purchased from the larger supply houses in rolls of one hundred lineal feet and in any width from twenty-four to thirty-six inches.

For apple trees the 24 inches width is usually the more convenient size. This is cut crosswise with tinners' snips or shears into 12-inch sections, making pieces 12x24 inches in size. These sections are carefully bent or rolled over a small, round piece of wood (a section of broom or fork handle will answer) shaping them into cylinders 2½ to 3 inches in diameter. It is well to allow the edges to lap about one inch.

The cylinders are placed about the stem of the trees where their own tension will close them securely.

Small Meshed Poultry Netting.—This protector is made of ordinary weight, galvanized wire poultry netting of one inch mesh. This is quite as effective against rabbits as the closer-woven wire cloth, but will not protect the trees from mice. This netting may be purchased in bales of 150 lineal feet and cut and shaped just as described for the wire cloth. These are very neat and sightly and do admirably for cultivated orchards, or wherever the method of culture or the environment does not favor the presence of field mice. In combination with a slight mound of soil about the base of the tree, mice will rarely prove troublesome.

Standard Poultry Netting.—It often happens that the planter of a few trees has at hand a quantity of old poultry netting of standard or 2-inch mesh. From this stock in hand quite serviceable protectors can be made by cutting out sections 18x24 inches in size and rolling them around a section of broom handle as described. The mesh being so large, the pieces are cut six inches wider in order that there may be at least two rounds of the netting encircling the stem of the tree. Rabbits and woodchucks will not be able seriously to injure a tree thus protected. This form presents no obstacle to the work of mice; but mounding slightly, in connection, will baffle these little pests.

Wood Veneer.—This style is effective against all kinds of rodents; but, as they form a tight, close, light-excluding cylinder, various forms of insect life thrive in the crevices and under the cover thus provided. The woolly aphis or root louse, when present in the orchard, increase in great numbers on the bodies of the trees under such covers. While the veneers are excellent protectors for the winter season, both from injury by rodents and from winter injury to the stems of the trees, they should be removed during the summer season. The different forms of wire cylinders are preferred.

Corn Stalks.—There is no device superior in effectiveness against rabbits and groundhogs than this, and certainly none cheaper for the farm orchard. There is practically no cost of material where corn is grown or cornstalks fed. A good plan is to take the bundles of stover as they come from the field, before feeding to the stock. Lay the bundle on a low platform or broad, low box, and "square-off" the butts with an ordinary "Lightning" hay knife. A solid block and a broad-ax may be made to answer, but the hay-knife is much better. Next cut off a two-foot length of the lower ends of the stalks in the same way. These sections may be fed to the stock either in a manger or in the feed-lot, where the blades will be cleanly and neatly stripped off. After a few days' feeding several hundreds or even thousands of these uniform length stalks may be rapidly gathered up and tied in bales for future use. Five or six stalks bound firmly about the stem of a young tree, with twine or short sections of baling or broom wire, will constitute a protector that will last not only for one season but for several or as long, usually, as the tree needs protection from rabbits. The stalks readily yield as the stem of the tree increases in size. In case wire ties are used for binding on the stalks, great care should be exercised to see that these are removed from about the tree when the stalks are taken off. If not removed they will drop down about the collar of the tree and become covered with soil and forgotten. Trees have been killed by wire girdling in this way. By mounding the bases of the trees slightly with fresh soil and firming it well, a stalk-protected tree is quite secure from all rodent enemies.

Combination Wire Cloth and Corn Stalks.—This form will appeal to the most exacting. The stalks protect the stems from rabbits, while the 8-inch wire cloth cylinders, cut from the same material completely baffle the mice even in badly infested orchards. The wire cylinders should be forced down two or three inches in the ground. These cylinders are formed from sections of wire cloth 8x12 inches in size. Cost, about 1 cent each.

When trees have attained the age of six or seven years they are usually beyond the period of injury by rabbits. We then have to protect only against mice. The short, galvanized wire cloth cylinder alone, well imbedded in the soil about the base of the tree, is quite sufficient even in badly infested orchards, except when unusually deep snows come and lie a considerable time on the ground. It may then be well to tread down the snow immediately about the trees to prevent mice burrowing about and feeding upon the stems above the protectors.

In combination with the soil or cinder mound, paper wrappers of different kinds are temporarily effective in protecting from rabbits; but these protectors should be removed during the summer season because of the fact that they afford excellent places for concealment of the larvæ of certain insects and for the woolly aphis.

A simple paper cylinder formed of ordinary printing, wrapping or even newspaper, will serve well for a single winter.

All paper wrappers should extend a little below the surface of the soil at the base.

Building Paper.—A good grade of building or "sheathing" paper is preferable to wrapping or newspaper for tree protection. According to grade, these heavier wrappers should cost but from one-tenth to one-fifth of a cent each or 10 to 20 cents per 100, if the paper be purchased by the roll of 500 square feet. These may be put on the trees in the form of a plain cylinder, or the paper may be cut into strips from four to six inches wide and wrapped spirally about the stem to the desired height, beginning at the base and fastened with twine in the usual way.

There are two points of superiority in the plan of spiral wrapping, over the cylindrical protector; first, a crooked bodied tree can be closely and neatly covered; second, the spiral wrapper is more resistant to the strong winds of winter which sometimes play havoc even with building paper protectors if not securely fastened with twine spirally applied.

Combination Wire Cloth and Building Paper.—This protector, when put on carefully, is trustworthy under almost all conditions. The wire screen discourages the mice while the paper wrapper is accepted by the rabbits as an invitation to look elsewhere for forage. The paper may be removed and the screen retained during the growing season.

Animal Blood.—Fresh blood from a slaughter house, applied as a paint to the stems of trees in autumn and again in mid-winter, will prevent the work of rabbits. Or, the bodies of the trees may be well rubbed with a piece of fresh pork or beef liver with the same results. These remedies are not effective against mice, however, and should be used in connection with banking or screening the bases of the trees.

Various repulsive and unnamable mixtures have from time to time been recommended as against the work of rabbits, but the above is just as serviceable, and much more cleanly to apply.

An Effective Wash.—A thick paint of lime, soap, carbolic acid and sulphur is recommended to protect fruit trees from injury by rabbits, sheep and mice. It is made as follows: Slake one peck of fresh, stone lime with old soap-suds, thinning to the consistency of whitewash. For the one peck of lime add one-half gallon of crude carbolic acid, four pounds of sulphur and one gallon of soft soap. Paint the trunks of the trees with this in late autumn.

The Modern Lime-Sulphur Mixture.—It has been found that the lime-sulphur mixture, such as is used for spraying for scale insects, is quite effective in preventing work by rabbits in the orchard and nursery. This is the ordinary 15-15-50 boiled mixture with which nearly all home owners are now familiar. It is used as an autumn spray, the stems of the trees being thoroughly covered with the mixture entirely to the ground.

For those who desire to prepare a small quantity of the lime-sulphur mixture for a few trees, to be used as a paint, the following will be helpful. Slake one pound of fresh stone lime in a small quantity of hot water. Or, one pound of ordinary hydrated or "prepared" lime may be used instead. Boil for one hour the one pound of lime with one pound of sulphur in one gallon of water. Thin the boiled mixture with enough hot water to make three and one-third gallons. This should be used while fresh, keeping it well stirred.

Conclusion.—If young trees be girdled in late spring just as growth is beginning, they may be successfully treated by binding about the wounded parts a heavy covering of smooth tenacious soft clay. A new bark will sometimes form beneath the clay if the inner bark or cambium be not entirely destroyed. It is safer, however, to insert a few long scions.

This is called "bridge-grafting." The sap circulation of the tree, cut off by the wound made by the rodents, is resumed through the scions which become a part of the tree—enlarging and growing together until, in after years, only a slight enlargement or "bulge" on the trunk of the tree thus treated will be noticeable.

In bridge-grafting, the wounds should be made clean and smooth with a sharp knife and covered entirely with grafting wax. The scions should be cut a trifle longer than the span to be bridged so that, when they are inserted, their curving form will tend to keep them firmly fixed in position. The two ends of the scions are cut to a thin, wedge form. Incisions are made in the bark with a narrow chisel—those above the wound sloping upward and those below sloping downward. Insert the scions firmly and wax heavily and securely all wounds made in the operation, especial care being exercised to press the wax in firmly and neatly about the points of union of scions with the body of the tree. The sectional drawing will show more clearly than printed description the manner of making the "bridge."—(O. E. S. B. 208.)

Cultivation Injuries.—Cultivation is frequently done in such a rough way as to cause serious injury. This can be largely prevented by the use of narrow singletrees and by protecting the ends with leather, or, better still, by using leather traces that go completely around the end of the singletree. The best way of treating wounds of this kind is by applying grafting wax or grafting clay and then covering the whole with burlap to keep it in place.

Root Galls.—Root galls are often exceedingly injurious. Some of them, however, do but little harm. Prevention is better than cure, and it is safest to refuse to receive nursery stock having such blemishes.—(U. S. E. S. B. 178.)

IRRIGATION OF ORCHARDS.

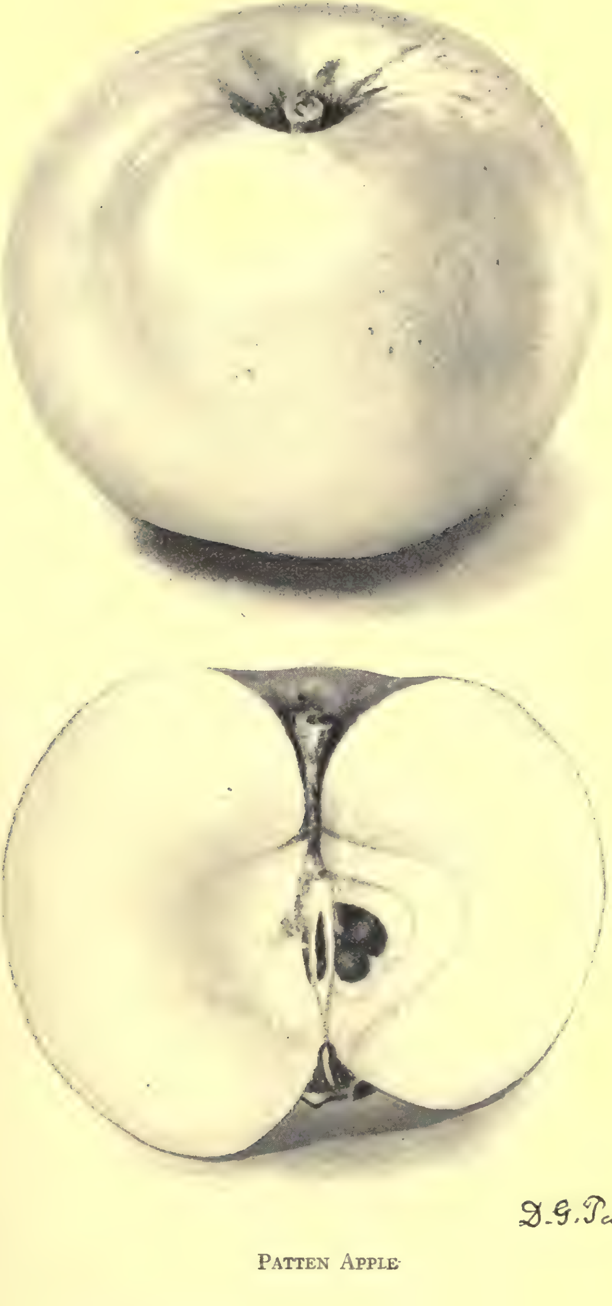
Selection of Lands for Orchards.—Care and good judgment should be exercised in the selection of an orchard tract. If it turns out well the profits are high, but if it fails the losses are heavy. It involves the setting aside of good land, the use of irrigation water, and somewhat heavy expenses in purchasing trees, setting them out and caring for them until they begin to bear.

Assuming that the climate and soil of the district selected are adapted to the kind of trees to be grown, the next most important things to consider are good drainage and freedom from early and late frosts. Low-lying lands under a new irrigation system should be regarded with suspicion, even if the subsoil be quite dry at the time of planting. The results of a few years of heavy and careless irrigation on the higher lands adjacent may render the lowlands unfit for orchards. On the other hand, the higher lands are not always well drained naturally. A bank of clay extending across a slope may intercept percolating water and raise it near the surface. Favored locations for orchards in the mountain States are often found in the narrow river valleys at the mouths of canyons. The coarse soil of these deltas, the steep slopes, and the daily occurrence of winds which blow first out of the canyons and then back into them, afford excellent conditions for the production of highly flavored fruits at the minimum risk of being injured by frost.

Proper exposure is another important factor. In the warmer regions of the West and Southwest a northern exposure is sometimes best, but as a rule the orchards of the West require warmth and sunshine, and a southerly exposure is usually most desirable. Natural barriers frequently intercept the sweep of cold, destructive winds, and when these are lacking, wind-breaks may be planted to serve the same purpose. Depressions or sheltered coves should be avoided if the cold air has a tendency to collect in them, a free circulation of air being necessary to drive away frost. The low-lying lands seem to be the most subject to cold, stagnant air.

While experience has shown that orchard trees of nearly all kinds can be successfully grown on soils that differ widely in their mechanical and chemical composition, it has also shown that certain types of soils are best adapted to particular kinds of trees. Thus the best peach, almond, apricot, and olive orchards of the West are found on the lighter or sandier loams; the best apple, cherry, and pear orchards on heavier loams; while walnut, prune, and orange orchards do best on medium grades of soil. The requirements of all, however, are a deep, rich, and well-drained soil.

Typical Water Supplies for Orchards.—Formerly most western orchards were supplied with water through earthen ditches. These leaky, unsightly channels, by reason of their cheapness, would have been quite generally retained had it not been for the increasing value



D. G. Passmore

Patten Apple

and scarcity of water. In many localities there is likewise great scarcity at certain times. These rapidly changing conditions have induced many water companies to save some of their heavy losses in conveying water supplies by substituting pipes for open ditches in earth, or else by making the ditches water-tight by an inpervious lining.

The high value and scarcity of water in natural streams have likewise induced orchardists to install pumping plants to raise water from underground sources. Reservoirs are also being built to supplement the late summer flow of streams which fail to provide enough water for all.

The few typical examples which follow may not only give the reader an idea of how orchards are supplied with water, but indicate also the customary division into tracts to serve this and other purposes.

The Lewiston Basin is located where Clearwater River flows into the Snake River in western Idaho, and varies from 700 to 1,900 feet above sea level. A few years ago water was brought from neighboring creeks and stored in a reservoir. The water required for orchard irrigation is conducted from this reservoir under pressure in two lines of redwood stave pipes over the rolling hills which separate the reservoir from the orchard lands. On these lands contour lines were first established, and each quarter section was afterwards divided into 40-acre tracts by 60-foot streets. These were further subdivided into eight 5-acre tracts, with a 20-foot alley through the center. The large conduits from the reservoir are connected to smaller lateral pipes laid in the alleys, and these in turn are tapped by 3-inch pipes, which furnish water to the 5-acre tracts.

The town of Corona, Cal., is hemmed in on all sides by lemon and orange orchards. The chief water supply for these groves comes from Perris Basin, 40 miles distant. The Temescal Water Company owns 3,600 ares of water-bearing lands in this basin, and at favorable points pumping plants have been installed. These plants are operated by motors supplied with current from a central generating station located at Ethenac. The discharge from each pump is measured over a rectangular wier having an automatic register. Small lined channels convey the water from the pumps to the main conduit. The concrete lining of this conduit is composed of one part cement to seven parts sand and gravel, having a thickness on the slopes of 2½ inches and on the bottom of 3 to 4 inches. The lining is rendered still more impervious by the addition of a plaster coat one-fourth of an inch in thickness, composed of one part of cement to two parts of sand. The cost was 5½ cents per square foot, or 55 cents per linear foot. The main conduit consists of about 30 miles of lined canal and 10 miles of piping 30 inches in diameter. The groves are laid out as a rule in 10-acre tracts, and piping of various kinds conveys the water from the main to the highest point of each tract, from which it is distributed between the rows in furrows.

A large part of the water used by the Riverside Water Company is pumped from the gravelly bed of the Santa Ana River. From thence it is conveyed in a main canal to the orchard lands and distributed to the groves in cement and vitrified clay pipes. The owner of a tract, whether it be 10, 20, 30, or 40 acres in extent, receives his supply at the highest corner through a hydrant box. Each hydrant box not only allows the water to pass from the end of a lateral pipe to the head flume of the tract to be irrigated, but also measures the amount in miner's inches under a 4-inch pressure head as it passes through.

On the Gage Canal System in Riverside County, Cal., the water supply for the tiers of 40-acre tracts is taken from the canal in riveted steel pipes varying from 6 to 10 inches in diameter. These larger mains are connected with 4, 5, and 6 inch lateral pipes of the same material, which convey the water to the highest point of each 10-acre tract.

The ditches conducting water from gravity canals to orchard tracts do not differ from the supply ditches for other crops.

Clearing and Grading Land for Fruit.—As a rule fruit trees are planted on land previously cultivated and cropped. One of the best preparatory crops for orchards is alfalfa. This vigorous plant breaks up the soil and subsoil by its roots, collects and stores valuable plant foods, and when it is turned under at the end of the second or third year leaves the soil in much better condition for the retention of moisture and the growth of young trees.

In the Bitter Root Valley, Montana, new land is first plowed 8 to 12 inches deep, then carefully graded and smoothed and seeded to red clover for one or two seasons. On the west side of this valley pine trees and pine stumps are encountered. These can best be removed by burning. A hole 1½ inches in diameter is bored through the base of the stump or tree in a slanting direction. It is near the surface of the ground on the windward side and about 18 inches above the surface on the leeward side. A fire is then built in the hole, using small twigs to start it. As the fire burns the opening is increased and larger limbs are inserted. In two or three days the stump will have burned out, the fire burning down into the roots to a depth of 12 to 14 inches. The cost of such clearing varies with the character of the land and the density of the growth. From $10 to $15 an acre will clear the land of stumps and it then costs $5 to $10 to get the unburnt roots plowed out and the land ready for planting.

In recent years large areas of wooded lands in both the Hood River and Rogue River valleys of Oregon have been cleared in order to plant apple trees. One of the methods employed in the Hood River district to rid the land of its growth of fir, pine, scrub oak, and laurel is similar to that just described. Another method consists in splitting open the stumps with giant powder and then pulling out the roots with a stump puller. Stump pullers of various kinds are used in California for a like purpose. The most powerful of these consists of a portable engine, windlass, and cable similar to an ordinary hoisting plant. A heavy chain is fastened to the tree at the proper height from the ground. To this chain the pulling cable is hooked and when the power is applied the tree is pulled out by the roots.

In New Mexico and Texas the mesquite is usually grubbed out by Mexicans, but in California, where labor costs more, such shrubs as mesquite, manzanita, and chaparral can be more cheaply removed by a stout pair of horses and a logging chain.

An effort should be made to establish a fairly uniform grade from top to bottom of each tract. This is done by cutting off the high points and depositing the earth thus obtained in the depressions. The length of the furrows should not exceed one-eighth of a mile and in sandy soil they should be shorter. As a rule, it is not difficult to grade the surface of an orchard so that small streams of water will readily flow in furrows from top to bottom.

Locating the Tree Rows.—In setting out orchards which are to be irrigated, the elevation of the surface of the ground should first be ascertained. This is usually done by making a contour survey by which each tract is divided up into a number of curved strips or belts. With these as a guide the direction of the tree rows can be readily determined. Where the trees are watered in basins or checks, flat slopes are not so objectionable, but in furrow irrigation a slope of about 2 inches to the 100 feet is necessary to insure an even distribution of water. When streams are to be run in the furrows the slope of the furrows may be increased to 8, 10, and even to 12 inches to the 100 feet. On slopes varying from 10 to 40 feet to the mile, the tree rows may therefore be located at the proper distance apart down the steepest slope. Under such conditions the trees are most commonly planted in squares. The location of the trees can be best fixed by the use of a surveyor's transit and steel tape. When these are not available, a woven-wire cable about three-sixteenths of an inch in diameter will answer the purpose. If apple trees are to be set out and it is desired to have them 32 feet apart, tags are inserted between the strands of the cable to mark this exact distance. A base line at the proper distance from the fence or one margin of the field is then laid down and long sighting stakes driven at each tag. The corner is then turned and a similar line is laid out. This process is continued until the location of the trees around each of the four sides of the tract has been fixed. The corners can best be turned with a 100-foot tape or link chain. First measure from the end of the base line a distance of 30 feet. Hold the one-hundred end of the chain at this point, and the 10-foot link at the corner; take the tape or chain at the 50-foot mark or link and pull both lines taut. A stake driven at this vertex will establish a point on a line at right angles to the first. When stakes have been set on all four sides the intermediate locations for the trees can be readily ascertained by sighting between corresponding marginal stakes.

Where the slope is steep and difficulties are likely to be encountered in distributing water, the equilateral, hexagonal, or septuple method of planting, as it is variously termed, should be adopted. It will be observed that in this method of planting the ground is divided up into equilateral triangles, with a tree at each vertex. The trees likewise form hexagons, and when one includes the center tree of each hexagon they form groups of sevens. Hence the name equilateral, hexagonal, and septuple.

The chief advantage of this mode of planting in irrigated districts is that it provides three and often four different directions in which furrows may be run. Having the choice of so many, it is not difficult to select the one which is best for any particular tract. The ground can likewise be cultivated in more ways and about one-seventh more trees can be planted to a given area than is possible in the square method.

In the past the trees of irrigated orchards have been planted too close. This is made clear to even the casual observer who visits the old orange groves of Riverside, Cal., the deciduous orchards of the Santa Clara Valley, California, or the apple orchards of the Hood River district in Oregon. Under irrigation systems peach trees should be spaced 20 to 22 feet, olive, pear, apricot, and cherry trees from 22 to 28 and 30 feet, orange trees 22 to 24 feet, apple trees 30 to 36 feet, and walnut trees from 48 to 56 feet apart.

On the Pacific coast the tendency toward wide spacing has induced many growers to insert peach fillers between other slower maturing trees, such as the apple and walnut.

Methods of Irrigating Orchards.—The usual way of irrigating orchards is by means of furrows. These vary in depth, length, and distance apart, but this diversity does not tend to create different kinds of furrow irrigation. The division of this subject is rather due to the means employed in distributing water from the supply ditch to the furrows. In some cases the distribution is effected by making openings in an earthen ditch, in others by inserting wooden or iron spouts in the ditch banks, while in many others flumes having the desired number of openings or pipes with standpipes divide the supply among the requisite number of furrows. These designs and methods will be described under their respective headings.

Earthen Head Ditches.—Permanent ditches at the head of orchard tracts should be located by a surveyor. The proper grade depends chiefly on the soil. If the soil is loose and easily eroded, a slow velocity is best. On the other hand, the velocity must be sufficiently rapid to prevent the deposition of silt and the growth of water plants. In ordinary soils, a grade of 2½ inches to 100 feet for a ditch carrying 2 cubic feet per second is about right. The amount of water to be carried varies from ½ to 2 or more cubic feet per second. A ditch having a bottom width of 24 inches, a depth of 6 inches, and sloping sides, ought to carry 1½ cubic feet per second on a grade of half an inch to the rod or 3 inches to 100 feet. Such a ditch may be built by first plowing four furrows and then removing the loose earth either with shovels or a narrow scraper. The loose earth may likewise be thrown up on the sides and top by means of a home-made implement like a scraper. Canvas dams, metal tappoons, or other similar devices are inserted in the head ditch to raise the surface of the water opposite that part of the orchard where furrows have been made and which is about to be watered. The chief difficulty in this mode of furrow irrigation arises in withdrawing water from the ditch and in distributng it equally among a large number of furrows. A skilled irrigator may adjust the size and depth of the ditch bank openings so as to secure a somewhat uniform flow in the furrows, but constant attention is required in order to maintain it. If the water is permitted to flow for a short time unattended the distribution is likely to become unequal. Parts of the ditch bank become soft, and, as the water rushes through, the earth is washed away, permitting larger discharges and lowering the general level of the water in the ditch so that other openings may have no discharge. Some of the orchardists of San Diego County, Cal., insert in niches cut in the bank pieces of old grain sacks or tent cloth. The water flows over these without eroding the earth. Another device is to use a board pointed at the lower end and containing a narrow opening or slot through which the water passes to the furrow. Shingles are also used to regulate the flow in the furrows. The thin ends of these are stuck into the ground at the heads of furrows.

Short Tubes in Head Ditches.—In recent years short tubes or spouts have been used in many of the head ditches of orchards to divert small quantities of water to furrows. These tubes are usually made of wood, but pipes made of clay, black iron, galvanized iron, and tin are occasionally used.

For nurseries and young trees especially, and also for mature trees, a cheap and serviceable tube may be made from pine lath, such as are used for plastering. The 4-foot lengths are cut into two equal parts and four of the pieces are nailed together to form a tube. One of these tubes when placed with its center 2 inches below the surface of the water in the head ditch discharges nearly three-quarters of a miner's inch of water, and if placed 4 inches below the surface will discharge more than 1 miner's inch. In southern Idaho the lumber mills manufacture a special lath for this purpose. It is ½ inch thick, 2 inches wide, and 36 inches long. If such tubes when thoroughly dry are dipped in hot asphalt they will last a much longer time. In some of the deciduous orchards of California a still larger wooden tube or box is used to bring about the same result. It is made of four pieces of ¾ by 3¾ inch redwood boards of the desired length. The flow through this tube is regulated by a cheap gate, consisting of a piece of galvanized iron fastened by means of a leather washer and a wire nail.

The orchardist who lives near a manufacturing town or city can often purchase at a low figure pieces of worn-out and discarded piping varying from ¾ to 2 inches in diameter. Such pipes when cut into suitable lengths make good substitute for wooden spouts. Tin tubes one-half inch in diameter and of the proper length have been used with good success. In compact soils, through which water passes very slowly, the furrows must be near together, and under such conditions small tin tubes are to be preferred.

In making use of tubes of various kinds to distribute water to furrows it is necessary to maintain a constant head in the supply ditch. This is done by inserting checks at regular distances. These distances vary with the grade of the ditch, but 150 feet is not far from being an average spacing. In temporary ditches the canvas dam is perhaps the best check, but in permanent ditches it pays to use wood or concrete. In this the opening is controlled by a flashboard which may be adjusted so as to hold the water at any desired height and at the same time permit the surplus to flow over the top to feed the next lower set of furrows.

Head Flumes.—Formerly head flumes for orchards were built of wood, but the steady increase in the price of lumber and the decrease in the price of Portland cement have induced many fruit growers to use cement instead. When built of wood, the length of the sections varies from 12 to 20 feet, 16 feet being the most common. The bottom width runs from 6 to 12 inches, while the depth is usually 1 to 2 inches less. Redwood lumber 1¼ inches thick is perhaps the best for the bottom and sides, and joists of 2 by 4 inch pine or fir are commonly used for yokes which are spaced 4 feet centers. Midway between the yokes auger holes are bored and the flow through these openings is controlled. A 2-inch fall for each hundred feet may be regarded as a suitable grade for head flumes, but it often happens that the slope of the land is much greater than this, in which case low checks are placed in the bottom of the flume at each opening.

A head flume composed of cement, sand, and gravel costs as a rule about twice as much as a wooden flume of the same capacity, but the early decay of wood, especially if it comes in contact with earth, makes the cement flume cheaper in the end. By means of a specially designed machine, which is patented, cement mortar composed of one part cement to about six parts of coarse sand is fed into a hopper and forced by lever pressure into a set of guide plates of the form of the flume. Such flumes are made in place in one continuous line across the upper margin of the orchard tract. After the flume is built and before the mortar has become hard, small tubes from ¾ to 1½ inches in diameter, the size depending somewhat on the size of the flume, are inserted in the side next the orchard. The flow through these tubes is regulated by zinc slides. Flumes of this kind are made in five sizes, the smallest being 6 inches on the bottom in the clear and the largest 14 inches.

At a slightly greater cost a stronger flume can be built by the use of molds. The increased strength is derived from a change in the mixture. In the machine-made flume the mixture of one part cement to five or six parts of sand is lacking in strength, for the reason that there is not enough cement to fill all the open spaces in the sand. In using molds medium-sized gravel can be added to the sand and the mixture resembles that of the common rich concrete. Such flumes can be built of almost any size from a bottom width of 10 inches to one of 40 inches and from a depth of 8 inches to one of 24 inches, but when the section is increased beyond about 240 square inches it pays better to slope the sides outward and adopt the form of the cement-lined ditch. The quantity of concrete required per linear foot of flume depends on its size and the thickness of its sides and bottom.

For large head flumes and laterals, many fruit growers first carefully prepare an earthen ditch which has carried water for at least one season and afterwards line the inner surface with cement concrete.

Pipes and Standpipes.—Head flumes, being placed on the surface of the ground, interfere with the free passage of teams in cultivating, irrigating, and harvesting the crop. Dead leaves from shade and fruit trees also clog the small openings in the flumes. These and other objections to flumes have induced many fruit growers of southern California to convey the water in underground pipes and distribute it through standpipes placed at the heads of the rows of trees. Both cement and clay pipes are used for this purpose.

The former are usually molded in 2-foot lengths, with beveled lap joints, and consist of a 1 to 3 or 1 to 4 mixture of cement and fine gravel and sand. The most common sizes are 6, 8, 10, and 12 inches in diameter, having a thickness of shell in the 12-inch pipe of 1½ inches which is reduced to a trifle more than 1 inch in the 6-inch pipe. Piping of this kind, when well made and carefully laid, will withstand a head of 10 to 16 feet. The clay pipe is similar to that used in cities for sewers and having stronger joints, withstands a greater pressure but costs more.

A line of pipe is laid about 2 feet below the surface from the feed main and measuring box across the top of the orchard, and as each row of trees is passed a standpipe is inserted. Various devices are employed to convey the water from the pipe to the surface of the ground at the head of each tree row and divide it up evenly among 4 to 6 furrows. One of the most common consists of a series of standpipes, the top of each set rising to the same elevation. At each change of elevation special standpipes are used and in these are inserted gates provided with overflows.

Occasionally a high-pressure pipe is substituted for cement and clay. This is tapped at the head and in line with each row of trees, and a small galvanized-iron pipe is inserted. These standpipes are capped by an ordinary valve which regulates the flow to each row of trees.

Making Furrows.—The length of the furrow is often governed by the size of the orchard. The rows of citrus trees seldom exceed 40 rods in length, but the apple orchards of the Northwest are larger as a rule. Even in large tracts it is doubtful if it ever pays to run water in furrows more than about 600 feet. Where the soil is open and water sinks readily through it, short furrows should be used, otherwise much water is lost in deep percolation on the upper part of the tract. An authority of San Diego County, Cal., after a careful investigation of this subject has reached the conclusion that on sandy or gravelly soil having a steep slope the proper length of furrows is 200 feet, while on heavier soils and flatter slopes the length may be increased to 600 feet.

The grade of furrows varies quite widely. In flat valleys it is often not possible to obtain a fall greater than 1 inch to 100 feet, while on steep slopes the fall may reach 20 inches per 100 feet. On ordinary soils a grade of 3 to 4 inches is to be preferred, and where the fall exceeds 8 to 10 inches to 100 feet the trees should be set out in such a way as to decrease the slope of the furrows.

The number of furrows in orchards depends on the age of the trees, the space between the rows, the depth of furrow, and the character of the soil. Nursery stock is irrigated by one or two furrows and young trees by two to four. A common spacing for shallow furrows is 2½ feet, while deeper furrows are made 3 to 4 feet apart. The general trend of orchard practice is toward deep rather than shallow furrows, a depth of 8 inches being frequently used.

The furrowing implement most commonly used by the orchardists of Orange County, Cal., consists of a sulky frame to which are attached two or three double moldboard plows. Those who prefer a small number of deep furrows use a 12 to 14 inch corn lister. A simple furrower may be made by attaching an arm to a cultivator and then fastening two shovels to the arm. The space between the furrows is 4½ feet and the depth is regulated by the lever arm of the cultivator.

Applying Water to Furrows.—In the Payette Valley, Idaho, 200 or more miner's inches are turned into the head ditch and divided up by means of wooden spouts into a like number of furrows. On steep ground much smaller streams are used. The length of the furrow varies from 300 feet on steep slopes to 600 feet and more on flat slopes. The time required to moisten the soil depends on the length of the furrow and the nature of the soil.

For the most part, the furrows are made parallel to the rows of trees. An arrangement of this kind is satisfactory in young orchards, but as the trees reach maturity their branches occupy more of the open space between the rows and prevent the making of furrows near the trees. A space of 6 to 12 feet square, according to the size of the trees, is not furrowed. This space usually becomes so dry that it is worthless as a feeding ground for roots. In order to moisten these dry spots, a larger stream is often carried in the two furrows next to each row of trees and the surplus is led across in short furrows in the manner shown in figure 20. Instead of continuing straight and cross furrows, use is frequently made of diagonal furrows, to moisten the dry space between the trees. This last method is best adapted to grades of 5 inches to the 100 feet or more.

A method and the cost of one irrigation is described as follows: The implement used to make furrows consists of three shovels attached to a beam which is mounted on a pair of low wheels. The driver sits on a riding seat and by operating a lever can regulate the depth of the furrows. A man and two horses will furrow out 10 acres in a day. For a distance of 150 feet from the top of the orchard the furrows are straight. They are then zigzagged to within 60 or 70 feet of the bottom, where the last three rows of trees are irrigated by basins which catch the surplus. In the case described the depth of furrow was 6 inches, length 800 feet, and distance apart 3 feet. A head of 50 miner's inches (1 cubic foot per second) was used on 10 acres. The streams when first turned into the furrows averaged about 2 miner's inches, but as the water approached the lower end they were reduced to 1 miner's inch or less, and this flow was run in each furrow for 12 to 24 hours. The items of cost for 10 acres were as given below:

Making furrows and basins	$ 6.50
Irrigating	3.00
Fifty inches of water, 24 hours, at 40 cents an hour	9.60
Rent of water stock	12.00
Total	$31.10

The Basin Method.—Orchards are sometimes irrigated by first forming ridges midway between the rows in two directions at right angles to each other. This divides up the tract into a large number of squares with a tree in the center of each.

When the ground is hard or covered with weeds, a disk plow is first run between the rows and then the loosened earth is formed into a ridge by a ridger. If the soil is light, sandy, and free from weeds, the disking is not necessary. Ridges are made in various ways of both wood and steel or some combination of both. It consists of two deep runners 14 to 18 inches high, 2 inches thick, and 6 to 8 feet long. These runners are shod with steel which extends part way up the inner side. They are 4 to 5 feet apart at the front end and tapered to 16 to 24 inches at the rear. The runners are held firmly in position by cross pieces on top, a floor, and straps of steel. The height of the ridges varies with the depth of water to be applied, which is from 4 to 9 inches. The ridges should be several inches above the surface of the water when a basin is flooded.

Several methods of flooding basins are practiced. In one a ditch is run from the supply ditch at the head through each alternate row space and the basins on each side are flooded in pairs, beginning with the lowest. In the other method water is allowed to flow through openings into each basin of a tier in a zigzag course from the top to the bottom of the orchard. In this plan the upper basins receive the most water. Under gravity canals, where water is abundant, the water is turned into the upper basin until it is full, when it overflows into the next, and so on down the tier. The irrigator then begins at the lower end and repairs the breaks, leaving each basin full of water.

The Check Method.—Where this method is practiced it frequently happens that land on which alfalfa has been grown is planted to fruit trees. In plowing down the alfalfa and setting out the trees, the levees undergo little change and the checks can be flooded if it is considered best. A better plan is to furrow the floor of each check. The water is admitted through the check box which was used for the alfalfa and conducted into a short head ditch, from which it is distributed to the furrows. The chief objection to this method is that the checks are too small for orchard tracts in furrow irrigation.

Time to Irrigate Orchards.—The best orchardists believe that frequent examinations of the stem, branches, foliage, and fruit are not enough. The roots and soil should likewise be examined. The advice of such men to the inexperienced is: Find out where the bulk of the feeding roots is located, ascertain the nature of the soil around them, and make frequent tests as to the moisture which it contains. In a citrus orchard of sandy loam samples are taken at depths of about 3 feet, and the moisture content determined by exposing the samples to a bright sun for the greater part of a day. It is considered that 6 per cent by weight of free water is sufficient to keep the trees in a vigorous condition.

Many fruit growers do not turn on the irrigation stream until the trees begin to show visible signs of suffering, as a slight change in color or a slight curling of the leaves. In thus waiting for these signals of distress, both trees and fruit are liable to be injured. On the other hand, the man who ignores these symptoms and pours on a large quantity of water whenever he can spare it, or when his turn comes, is apt to cause greater damage by an overdose of water.

Number of Irrigations per Season.—For nearly half the entire year the fruit trees of Wyoming and Montana have little active, visible growth, whereas in the citrus districts of California and Arizona the growth is continuous. A tree when dormant gives off moisture, but the amount evaporated from both soil and tree in winter is relatively small, owing to the low temperature, the lack of foliage, and feeble growth. A heavy rain which saturates the soil below the usual covering of soil mulch may take the place of one artificial watering, but the light shower frequently does more harm than good. The number of irrigations likewise depends on the capacity of the soil to hold water. If it readily parts with its moisture, light but frequent applications will produce the best results, but if it holds water well a heavy application at longer intervals is best, especially when loss by evaporation from the soil is prevented by the use of a deep soil mulch.

Duty of Water in Orchard Irrigation.—The duty of water for 1 acre as fixed by water contracts varies all the way from one-fortieth to one four-hundredths of a cubic foot per second. In general, the most water is applied in districts that require the least. Wherever water is cheap and abundant the tendency seems to be to use large quantities, regardless of the requirements of the fruit trees. In Wyoming the duty of water is seldom less than at the rate of a cubic foot per second for 70 acres. In parts of southern California the same quantity of water not infrequently serves 400 acres, yet the amount required by the fruit trees of the latter locality is far in excess of that of the former.

In recent years the tendency all over the West is toward a more economical use of water, and even in localities where water for irrigation is still reasonably low in price it is rare that more than 2½ acre-feet per acre is applied in a season.

The most reliable and in many ways the most valuable records pertaining to duty of water on orchards have been obtained by the water companies of Riverside County, California. Here more or less irrigation water is used every month of the year. In the following table is given the average duty of water per month in acre-feet per acre under the same system from December 1, 1901, to November 30, 1908, a period of seven years. The table also includes the average monthly rainfall at Riverside, Cal., for the same period, and adding the quantity of water applied in irrigation in any one month to the rainfall of that month gives the total moisture received by the soil.

Water Used Under Riverside Water Company's System (1901-1908).

Month.	Average depth per acre.	Average rainfall.	Total water applied.
	Feet.	*Feet.*	*Feet.*
December	0.159	0.109	0.268
January	.123	.170	.293
February	.046	.190	.236
March	.078	.316	.394
April	.177	.068	.245
May	.291	.023	.314
June	.274	.003	.277
July	0.272	0.002	0.274
August	.269	....	.269
September	.243	.015	.258
October	.189	.043	.232
November	.169	.073	.242
Total	2.29	1.01	3.30

Evaporation Losses from Orchard Soils.—A light shower followed by warm sunshine may refresh the foliage of fruit trees, but its effect on the soil is more likely to be injurious than otherwise. A brief, pelting rain followed by sunshine forms a crust on the surface of most soils, and if this is not soon broken up by cultivation it checks the free circulation of air in the soil and also tends to increase the amount of water evaporated.

It has been found that the amount of moisture held by the soil, the temperature of both soil and air, and the rate of wind motion are the chief factors in the evaporation of water from soils.

The results of experiments have shown that when the water is applied to the surface of orchard soils the loss by evaporation is very great so long as the top layer remains moist. Even in light irrigations this loss in forty-eight hours after the water is put on may amount to from 10 to 20 per cent of the volume applied. In order to reduce this loss and moisten the soil around the roots of trees, the practice of running small streams of water in deep furrows has become quite common. In applying water in this way the top soil remains at least partially dry, the bulk of the water soon passes beyond the first foot, and the surface can be cultivated soon after the water is turned off.

Soil Mulches in Checking Evaporation.—The surface earth-mulch (which can be secured only by cultivation) conserves the moisture stored in soil by checking capillary action, and by preventing evaporation from all the soil except the mulch itself; and it also permits air to enter the sub-soil freely. Western orchardists can prevent the greater part of the evaporation losses by cultivating orchards to a depth of at least 6 inches as soon as practicable after each irrigation.

Loss of Water Due to Percolation.—In all modes of wetting the soil, but more particularly when deep furrows are used to distribute the water, a part is liable to sink beyond the deepest roots. As a rule, the longer the furrow the greater is the loss from this cause.

One of the best ways of finding out whether much water is lost by deep percolations is to dig cross trenches as deep as the feeding roots go. The moisture which passes the deepest roots in its downward course may be considered wasted.

Removal of Waste Water.—The loss of water is not the only effect of deep percolation. The water which escapes in this and other ways usually moves through the soil at a rather slow rate of speed until it reaches some underground body of water at a lower level. In case orchards have been planted at these lower levels when the subsoil was dry, care should be exercised in observing the rise of the ground-water level. The small post-hole auger is one of the most convenient tools to use in making test wells to keep track of the behavior of the ground water. Before the deepest roots of the fruit trees are submerged, artificial drainage ought to be provided. Otherwise the ground water will at first lessen the yield and finally destroy the trees.

The drainage of orchard tracts usually progresses in more or less distinct and separate stages. When the ground water begins to be a menace, the natural ravines in the vicinity are cleared of weeds and other rubbish and deepened. If the ground water continues to rise, the open drains are deepened and extended or else the excess water is withdrawn through covered drains. Open drains in orchards occupy valuable land, obstruct field work, and are expensive to maintain. Some of these objections can be lessened if not removed by locating such drains along the lower boundary of the tract. When this plan is followed, covered drains are frequently laid among the trees and discharge into the open drains. Sometimes the source and direction of the waste water which is waterlogging an orchard can be traced beneath the surface. In this event it is well to try to intercept its passage before it reaches the trees. This can be done by an open drain, but a covered pipe drain is preferable. When lumber is cheap, box drains may be used. Where lumber is high in price, it will be more economical to use pipe drains made of either clay or cement. The former is most frequently used for sizes ranging from 4 to 8 inches in diameter and the latter for sizes 10 inches and over. The clay or tile drains are made 1 foot in length, but in using cement for the larger sizes the length may be increased to 2 and even 3 feet.

The drainage of irrigated lands differ in many respects from that common to the humid States of Iowa, Illinois, or Ohio. In irrigated districts the drains are larger and are laid deeper. While 4-inch tile drains may be used in places, 6-inch drains are to be preferred, and should be considered as the smallest desirable size. The depth at which they are laid ranges from 4 to 7 feet, and 5 to 6 feet are required for orchards. A grade of 5 feet to the mile is about the least that should be used, and wherever practicable it should be increased to 10 feet to the mile.

In laying drains that are likely to become clogged with silt or roots, or both, a small cable is laid in each line, and at distances of 300 to 500 feet sand boxes, to obviate trouble, are placed so as to facilitate cleaning the tiles with suitable wire brushes.

Growing Crops Between the Tree Rows.—The large majority of California fruit growers do not grow marketable crops between the trees. They believe in clean culture, except where leguminous crops are used to renovate and fertilize the soil. From the standpoint of the large commercial orchard and the well-to-do proprietor, this practice has much to recommend it. The planting of such an orchard is regarded as a long-time investment. Little if any returns are expected for the first few years, but when the trees approach maturity and are in full bearing the anticipated profits are supposed to compensate the owner for all the lean years. Any treatment, therefore, which tends to rob the soil of its plant food when the trees are young or to retard their growth is pretty certain to lessen the yields and the consequent profits in later years. One writer tersely expressed the prevailing opinion on this question in the following language: "All intercultures are a loan made by the trees to the orchardist. The term may be long and the rate of interest low, but sooner or later the trees will need restitution to the soil of the plant food removed by intercropping."

Notwithstanding this, the poor man must needs make the loan or his children may starve. The settler on a small tract set out to young trees can not afford, if his means are limited, to wait four or five years for the first returns. He must produce crops between the rows, and the question for him to consider is how this can be done with the least possible injury to the trees. A plentiful supply of water and a deep, rich soil are the essentials of intercropping. In districts that depend on a meager rainfall of 15 to 20 inches per annum, or where irrigation water is both scarce and costly, the practice becomes of doubtful value under any circumstances.

Shallow-rooted plants are considered the most desirable for this purpose. Squash, melons, sweet potatoes, tomatoes, and peanuts are the most common in California. The cultivation is done with one horse and a small cultivator. A clear space 3 to 4 feet wide is left on each side of the young trees. In the Verde River Valley of Arizona, strawberries, lettuce, onions, and melons are raised in the young orchards. In parts of Idaho, alfalfa fields are frequently plowed under to plant trees. When this is done, berries, beans, melons, onions, and tomatoes can be grown between the rows for several years without any apparent injury to young trees. In northern Colorado, raspberries, gooseberries, currants, as well as corn, beans, and peas are often planted in orchards, while in southwestern Kansas it is usually cabbage, melons, and sweet potatoes.

In the young apple orchards of Hood River Valley, Oregon, strawberries are frequently planted between the rows. The manager of a large apple orchard company in Montana states that no appreciable effect is noticed on apple trees as a result of growing potatoes, cabbage, beans, onions, and other vegetables between the trees providing the intercrops are well cultivated and irrigated. In the fruit districts of Washington, intercropping is a common practice. In 1907 a fruit grower raised on 10 acres of two-year-old trees cantaloupes, tomatoes, peppers, cucumbers, corn, radishes, beans, peas, potatoes and turnips, all of which netted him $2,086.50, or an average of $208.65 an acre.

While opinions differ regarding the wisdom of growing such crops as have been named between the tree rows, most fruit growers are convinced of the beneficial effects of cover crops.

The cost of such cover crops as peas, vetch, or clover includes the seed, the labor of sowing it, the water, and the time required to apply it. These items amount to from $2.50 to $3.25 per acre. Twenty tons per acre of green material is perhaps an average crop. In this tonnage there would be about 160 pounds of nitrogen, which at 20 cents per pound represents a value of $32 per acre for a cover crop like vetch.

When water is used outside of the regular irrigation period or, which is in many cases equivalent, outside of the growing season, it is termed winter irrigation. Over a large part of the arid region the growing season is limited by low temperatures to 150 days, or less, and when the flow of streams is utilized only during this period much valuable water runs to waste.

It was for the purpose of utilizing some of this waste that the orchardists of the Pacific coast States and Arizona began the practice of winter irrigation. The precipitation usually occurs in winter in the form of rain, and large quantities of creek water are then available. This water is spread over the orchards in January, February, and March, when deciduous trees are dormant. The most favorable conditions for this practice are a mild winter climate; a deep, retentive soil which will hold the greater part of the water applied; deep-rooted trees; and a soil moist from frequent rains.

In the colder part of the arid region winter irrigation is being practiced with satisfactory results. The purpose is not only to store water in the soil but to prevent the winterkilling of trees. Experience has shown that it is not best to apply much water to orchards during the latter part of the growing season, since it tends to produce immature growth which is easily damaged by frost. In many of the orchards of Montana no water is applied in summer irrigation after August 20. Owing, however, to the prevalence of warm chinook winds, which not only melt the snow in a night, but rob the exposed soil of much of its moisture, one or two irrigations are frequently necessary in midwinter.—(F. B. 404, 1910.)

DRAINAGE OF IRRIGATED LANDS.

Lands Needing Drainage.—Irrigated lands needing drainage may be divided into three classes: (1) Those injured by excess of water only; (2) Those affected by an excess of both water and alkali; (3) Those having an excess of alkali only.

The first class is the least extensive of the three, the extent of injury depending upon the value of the crops that may be grown on the land when dry. The greatest danger of serious loss in this kind of land is that alkali may accumulate in injurious quantities with the lapse of time. In the irrigated region there is very little seepage water which does not contain some alkali in solution, which tends to accumulate to an injurious degree in saturated land. Inquiry into the history of lands which have become badly affected with both alkali and water show that when injury first became noticeable such lands could have been protected from further injury with as much profit as attended the reclamation of lands affected by water only.

It is to the second class that most of the lands belong which now need drainage in the irrigated sections. Alkali accumulations usually follow accumulations of seepage water. If one admits that this condition is a forerunner of total abandonment, surely no argument is necessary to convince him that such lands belong to the class that should be drained. Lands of the third class are principally those in the virgin state, having enough alkali uniformly distributed through the soil to a depth of 6 feet to cause crop failure after a few years of irrigation, because of insufficient underdrainage. If irrigated lightly, the alkali will in time become concentrated at the surface, and if irrigated copiously, without underdrainage, water-logging will follow.

Alkali and Ground Water.—The relation of alkali to drainage is important and must be taken into account. In speaking of alkalies in his book on "Soils," Hilgard says:

"They are the natural result of a light rainfall, insufficient to leach out of the land the salts that always form in it by progressive weathering of the rock powder, of which all soils largely consist."

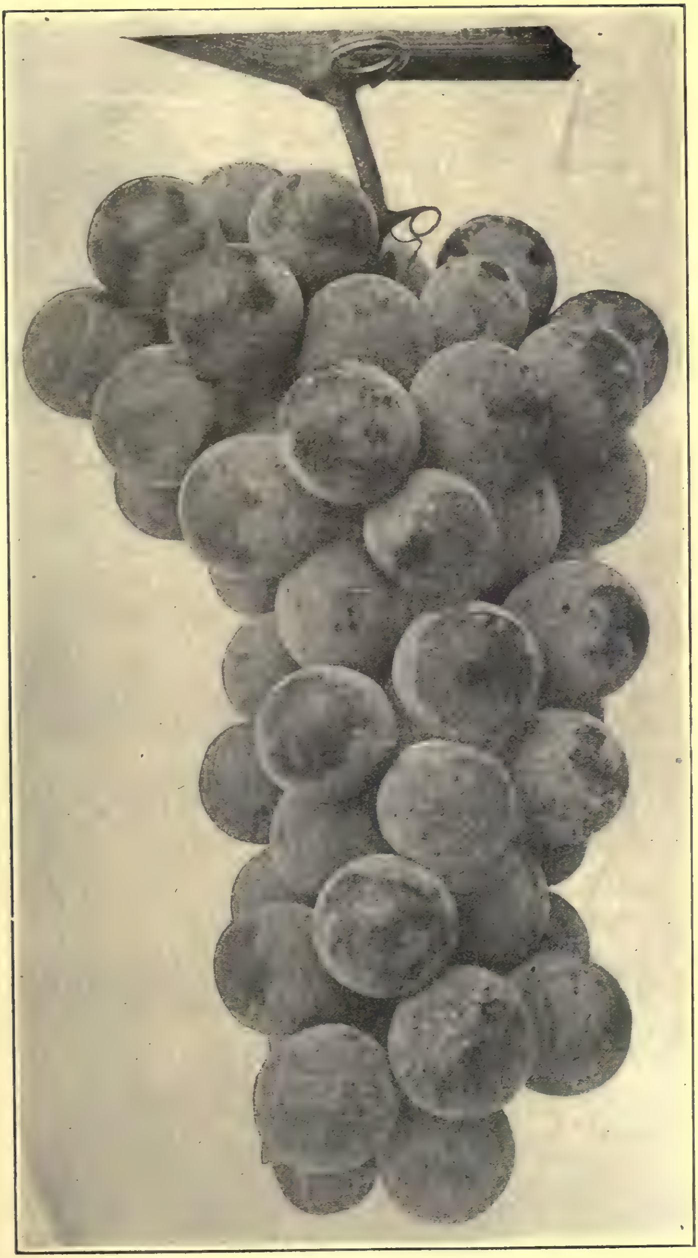
Ordinary alkali is made up of one or more of the following salts in varying proportions: Sodium chloride (common salt), sodium sulphate (Glauber's salt), magnesium sulphate (Epsom salt), calcium chloride, and calcium sulphate, all of which are white alkalis, and sodium carbonate (sal-soda), or black alkali. The latter is so called on account of the dark stains on the ground caused by the dissolution of the soil humus or vegetable matter. These salts and also the mineral plant foods are readily soluble in water, so that in the humid countries the constant leaching removes not only the injurious salts but also part of the plant foods. This accounts for the intrinsic fertility of the arid lands as compared with humid lands. The account of the origin of alkali naturally suggests the control by irrigation and underdrainage.

Of the fundamental principles, those relating to ground water and its movements are perhaps the most important. There is no question that seepage is an actual accompaniment of all irrigation. It has been found in all irrigated countries, doing damage and requiring drainage. The sources of supply are leakage from canals, surface applications, and precipitation. If the soil has the capacity for discharging this water as fast as it is supplied no damage will be done. If, on the other hand, more than its capacity is supplied trouble will surely follow.

A proper appreciation of seepage conditions often involves a knowledge of the ability of water to transmit pressure between two points, due to differences of elevation. This is often manifested in irrigated sections by ground water springing up through the innumerable soil pores. Such a condition indicates a porous substratum filled with water exerting a pressure. When this substratum is too deep to cut into by a drain, outlet wells connecting with the drains at an ordinary depth afford the best solution.

Another physical property affecting the movement of ground water and of great importance is that called capillary attraction. This phenomenon was named from the inherent ability of liquids to rise in small hair-like or capillary tubes above their free surfaces. Water rises higher in the tubes and also in soil particles than any of the other liquids. This property is most essential to plant life and crop production, but uncontrolled in alkaline soils, it hastens the accumulations of alkali at the surface. In soils varying from coarse sand to very fine clay, water will rise by this attraction from 2 to 6 feet. When the surface is allowed to become hard and baked, as when abandoned or allowed to stand idle, a surface tension is formed which increases this attraction and the consequent evaporation. It is the evaporation of large quantities of water containing alkaline salts in solution that does the damage. The evaporated water passes off nearly free, leaving the alkali in the surface soil. Experiments have shown that of the water applied in ordinary irrigation, without cultivation, from 30 to 50 per cent is evaporated from the surface. If, in addition to this, seepage water from higher lands or canals containing much alkali is within reach of capillary attraction, and the surface poorly cared for, thus increasing evaporation, alkali accumulations surely follow. A minimum depth of 4 feet for drains, with cultivated or shade crops, has been the practice of some of the drainage engineers though deep drainage from 5 to 6 feet is preferred.

Plans for Drainage.—The soils of the arid regions have not been subject to percolating water since their formation, as the humid soils have been, and consequently are without the drainage pores of the latter. If they have any water pores at all, they are those of the water doing the damage. The water applied to the higher lands affects the lower lands, where it flows out or comes near the surface, whether in light or heavy soil. In moving laterally through the body of the soil the water will flow along the lines of greatest slope and will not drain well into tile lines parallel to its movement. The drainage water finds its way through some special underground passage, or stratum, or some modification of these, rather than uniformly through the soil. The method of intercepting the water as it enters the field or soil, either by lateral seepage or some lower passage, is highly essential to success. However, intercepting drains are not all that are necessary. In nearly every instance outlet lines



Campbell Grapes

through the lowest wet portions are absolutely necessary, as is the case in humid sections.

Before drainage work can be taken up with any surety of success these underground conditions must be determined. If expensive mistakes are to be avoided, the subsoil examinations must not be neglected. The first method of making such examinations is that of digging test pits. Under ordinary conditions a depth of 6 feet can be reached without any difficulty. The test pit is also valuable for showing the nature of the digging for which special methods may be necessary. Another method is to use a soil auger, made of a 2-inch wood bit and ½-inch gas pipe, with which holes can be put down 12 feet, if gravel is not present. A long steel rod probe ⅝ inch in diameter can often be used to advantage in soft ground.

The kind of drain to be employed in farm drainage will be determined largely by local conditions. Open ditches are sometimes used for farm drainage, but more often for outlet and main drains. The principal objections to the use of open ditches for form ditches are the loss of land and the high initial cost if sufficient side slope is given them. If side slopes are left steep the maintenance expenses are high.

Covered drains may be divided into the following forms: Tile, lumber boxes, stone, brush, and mole-plow drains. Burned clay tiles, chiefly in a round form and in 1-foot sections, have been in use for more than four hundred years and have proved satisfactory. They have been known to endure for one hundred years. Some kinds of clay tile, when left upon the surface of the ground, will be disintegrated by soil alkali and by freezing.

Stone box drains have not been used to any extent in these districts so far as known, but brush and loose rock drains have been observed to fail by filling with sand and silt.

If farm drains must be laid along lines of water-loving trees and within 100 feet of them, the drains should be open ditches to prevent roots from obstructing them. The need of covered drains in orchards requiring drainage has necessitated a method of removing the roots without removing the tile. In California, cables are strung through the tile and root brushes pulled through short sections.

The questions of locating the lines and determining their sizes and depths will have to be determined by judgment, applying the fundamental principles herein stated. No general directions, such as a gridiron, double main, and single line or parallel systems, commonly used for drainage in humid districts, can be given for this kind of drainage. Such systems, with parallel lines 1 rod apart, might fail entirely if applied to some irrigated fields. If after careful examination the trouble is located as lateral seepage, a single line should be laid across the line of greatest slope 2 to 6 rods below the upper line of the wet spot. Such spots are usually small and one line may be sufficient, but an outlet line or branch should be laid through the low ground or basin. The distance down the slope affected by a drain will vary from 300 to 2,000 feet, according to local conditions. If the source is found to be in particular spots a branch for each spot will be necessary. Wells as outlets for water-bearing porous substrata should be located at the end of the pocket if it pinches out, and on the lowest ground if it extends all the way under the tract.

Lateral and main outlet drains should be clear to a depth of 5 feet, especially if they are intended for farm outlets on such land. The depth of covered drains for arid soils is determined by two factors. The first is the depth of the drained soil necessary for different crops. Fruit trees and alfalfa should have from 5 to 6 feet, and still greater depths are advantageous. The other factor in alkaline lands is capillary attraction. The height to which water will rise and evaporate in large quantities is the minimum depth allowable for ground-water level. Generally the water should be kept from 4 to 6 feet below the surface to satisfy these requirements. The minimum grade is 0.1 per cent and may be increased to as much as 5 per cent if necessary. Sizes from 4 to 6 inches will be sufficient for laterals in clay soils, with larger sizes for coarser soils. Fewer drains are needed in the irrigated sections than in the humid.

Plans for drainage other than small inexpensive lines should always include surveys. Level surveys, both preliminary and final, are absolutely necessary. The need of surveys for expensive tile or open ditch work ought not to be questioned. The enormous losses to farmers and co-operative companies in the past, when constructing irrigating works without competent engineering supervision, should be a lesson, and similar mistakes should not be repeated in undertaking expensive drainage works. At the time when final surveys are made the lines should be tied up to or located with reference to permanent marks, and a map of the system made. Such a map may prove valuable in planning future extensions and in other ways, when otherwise the exact location would be forgotten.

Field Construction.—The tools most used for digging trenches are trenching spades, shovels, and tile scoops. The digging for farm drains should always begin at the outlet, finishing the work as it proceeds, except completing the back filling. For trenches not deeper than 5 feet and for sizes of tile up to 12-inch, the top width need not be more than 18 inches. To insure proper alignment one side should be lined for the first spading. The last 16 inches should be removed in the last spading and the bottom graded at the same time. The work is much more easily done this way than if the digger were lower in the trench, and the bottom will remain firmer if not mushed up by constant tramping. Very few trenches can be finished in the irrigated districts without the trouble caused by the banks caving in, so that it is necessary to keep the tile laid and the trenches partly back filled up to within a few feet of the finished trench, and for that reason two or three diggers with one tile layer make the best team. With proper care the grade should only vary within one-fourth inch of true grade.

Laying tile is an important part of the proper construction of drains, even when the trench is made straight and on a uniform grade. The first item of importance is providing a firm foundation on which to lay the tile. In irrigated lands there are often soft spots which need some special treatment. The best method in such cases is to lay long boards in the trench upon which to lay the tile. If some such precaution is not taken one or more tile may settle or be pressed out of alignment and form a complete obstruction. When laying tile through an orchard with the intention of operating a brush or root cutter, boards with cleats on each side to hold the tile in true alignment are sometimes used. Tiles are not always cut off squarely, and when laid they should be turned until the tops set closely together, leaving the bottoms open for water. The ground should be firm enough to hold a man on a blinded tile, and the tile layer should work from the tile, if need be. Tile should always be carefully covered or blinded, as it is called, as soon as it is laid; and, for safety, the trench should be back filled enough to prevent the banks from caving in. Sand-trap boxes should always be put in at intervals of 300 to 500 feet, when fine sand or silt troubles occur, and also in orchards. These may be used as inlets for water when flushing tile or boxes.

After the tiles have been blinded and the trench partly filled by hand, the balance of the filling may be done with horses and plow. Three horses and a long evener are used for the first plowing. This plowing should be from the edges of the trench, after which a team may be used, one horse walking in the trench. It is not necessary to fill loosely so that the water may get into the tiles. Tramping and tamping are necessary to prevent surface water from entering and doing much damage. For the same reason, all brush and weeds should be removed, and not used for filling. The plowing should be continued until a heavy black furrow is worked up over the line.

Subsequent Care Necessary.—Attention to drainage should not cease when the system is installed. Upon the subsequent care and treatment of the drains and drained fields will depend the final efficiency. One of the greatest sources of trouble, in covered drains especially, has been the damage resulting from surface water running into the trench. In some soils it has been necessary to place boxes or flumes for carrying irrigation water over trench lines to keep the water from finding its way down through the loose soil to the drain with resultant obstructions. These troubles occur in sandy and silt loams but not in clay loams. Tree and brush roots cause much trouble by growing into covered drains in search of water, and then developing enough water roots to seriously interfere with the flow of water. To prevent excessive evaporation the proper cultivation of the surface is necessary. Where possible such soils should be cultivated after each irrigation so as to form a mulch on the surface. Shade crops, such as alfalfa, are also useful in preventing evaporation. Cropping and copious irrigation are absolutely necessary for reclaiming alkalied lands after underdrainage is supplied.—(F. B. 371.)

Drainage of Humid Soils.—All orchard lands should be thoroughly surface-drained and under-drained. No orchard can endure for a great length of time with stagnant water either on the surface or within the soil. All surplus water from excessive rainfall or from other causes should be promptly removed by either surface or subdrainage. If the natural formation of the land does not afford such prompt drainage it must be provided artificially. Surface ditches or furrows between the rows of trees may afford temporary drainage, but they are objectionable on other accounts that will be apparent; for an orchard thus drained will be difficult to get over in its necessary care and in gathering and handling the fruit. Underdrainage is far better on these accounts; besides, it is much more thorough, especially if accomplished by means of well-laid tile. A thorough breaking up of the subsoil will afford temporary drainage in a stiff clay soil, but in a few years the soil will again become compact, when it will require restirring. But in all cases the planter must be the judge of the special drainage requirements of his soil and location.—(F. B. 113.)

HARVESTING, MARKETING, AND STORING FRUIT.

Classes of Fruit Growers.—The first step in a discussion of marketing is a classification of the purposes of the given enterprise. Classified in respect to the objects in view, there are two kinds of fruit-growing,—that which desires the product primarily for home use, and that which desires it primarily for market. Of market or commercial fruit-growing, there are again two types,—that which aims at a special or personal market, and that which aims at the general or open market. The ideals in these two types of fruit-growing are very unlike, and the methods and the varieties which succeed for the one may not succeed for the other.

The man who grows fruits for the special market has a definite problem. The product is desired for its intrinsic qualities; and special products demand special prices. The man who grows fruit for the world's market, has no personal customer. The product is desired for its extrinsic or market qualities; and the world's products bring the world's prices. The special market fruit-grower generally works on a small base. The world's market fruit-grower works on a large base; or he sells to another who, by combining similar products of many persons, is able to command the attention of the market. Failure to distinguish these two categories is the result of a confusion of ideas. One grows fruit either for a special and personal market, in which case he looks for his own customer and is independent of general trade; or he grows what the market demands, and allows the machinery of trade to handle the product. In the latter effort, the American fruit-grower is pre-eminent; but in the former he has made little more than a beginning. The fact is that in the staple or large-area crops, the demand regulates the supply; whereas, in products which are essentially luxuries, amenities and accessories, the supply largely regulates the demand. In fruits there are some types or varieties which are staples for that group—staples in the sense that they are adapted to cultivation over wide areas and to be sold in the general and open markets. In apples, the Baldwin and Ben Davis are staples; Chenango and Lady are accessories. It follows that general or staple products find their best outlet in the general and open markets; special and accessory products find their only outlet in particular and personal markets.

This law is well illustrated in the market for glass-house products. Persons wonder that there should be sale for forced strawberries after the southern-grown product is in the market; but the fact is that one does not compete with the other. They are not purchased by the same parties. There is a market for glass-house produce and a market for field-grown produce; if the glass-house produce is offered in the other market the prices are not sufficient to pay the cost. Shall apples be grown on free stocks or on dwarfs? Whichever is liked; but with the dwarf-grown fruit one cannot compete in the open market. One cannot afford to sell dwarf-grown apples in barrels; such apples cost too much to raise. One cannot afford to grow Baldwin or Ben Davis on dwarfs, for apples thus grown cannot compete with large-tree orchards; and the gain in quality (due to the better care) of such low-quality varieties when grown on dwarfs, costs more than it is worth. The dessert apples can be profitably grown, perhaps, on dwarfs, provided they are put into a dessert market. The staples may be sold to the itinerant buyer, but the special products must be handled by the producer or his agent. Many grow fruit, but miss the market! These facts respecting the two classes of products and markets are the most imperative lessons for the American fruit-grower to learn. The foreign market may be expected to increase. European consumers desire our fruit. It is handsome, uniform, and much of it is of excellent quality. It is also well packed; or, rather, that which is not well packed does not reach the discriminating consumer. The English are now well acquainted with American apples, and fruit-buyers on the Continent, particularly in Germany, are learning to know them. The foreign market is only fairly opened; it is not yet supplied. It is believed that the European fruit-growers cannot compete with the American in general-market fruit and they are looking for a growing trade in American produce. As exportation increases the more discriminating the foreign market will become. Greater and greater attention must be given to packing and grading, selection of varieties, and particularly to good tillage, thinning and spraying; for spraying gives a better keeping as well as a sounder fruit.

There are good and bad years in fruit-growing, as there are in manufacturing or store-keeping. The fruit-growers should go into the business, therefore, as a long-time or more or less permanent undertaking, expecting to become more adept each year. He should then distinguish the type of market for which he desires to grow. If he is to compete in the general open markets he must work on a comparatively large base. The man who has only a small area will generally do best in the growing of special things—if he have sufficient skill—for personal markets. As a people, Americans are not diverse enough in fruit-growing. Too many aim at the general, common market. It seems that success in the general metropolitan and export markets is to be more and more secured by large-area fruit-farming, and that other fruit-farmers must develop sufficient skill to raise choicer things for more restricted and better markets. As a whole, fruit-growing is not overdone, particularly if the foreign markets are properly encouraged and supplied; but in particular places and cases it is overdone. Some fruits are not capable of indefinite extension. Success in fruit-growing is quite as much the hunting out of a market as the raising of the fruit; and the market problem should be clearly in mind from the moment the plantation is planned.—(Cornell E. S. B. 153.)

The one great object in growing fruit is to sell it at a profit. Fruit-growing is a business, and as such is dependent upon business methods and principles quite as much as the manufacture and sale of boots and shoes, of steel implements, or of other articles. The manufacturer realizes that the success of his business depends upon the proper distribution and sale of his products, and he pays as much attention to the selling as he does to the manufacturing. It is the business of the fruit-growers, either for themselves or through their agents, to study commercial methods and principles and apply them to their industry. With the establishment of better distribution and business methods in marketing fruits, the dangers from overproduction will largely be avoided.

This means, first of all, the production of first-class fruits, uniformly and honestly graded and packed and delivered to the consumer in sound and attractive condition. This is the business of the growers, and is the fundamental factor upon which depends the success of the industry. Too often the growers have ascribed the cause of their difficulties to others—to the shippers, to the transportation companies, to commission merchants, or even to the weather—losing sight of the fact that with the exercise of a little care and good judgment on their part many of these difficulties would not exist. It frequently happens that after a grower has used the utmost care in producing his crop he nullifies all through the handling he gives it in preparing it for market. It does not matter how excellent his orchard practices are, if his fruit does not reach the markets in sound and attractive condition he may find that he receives no more for his crop than a more careless or slipshod neighbor, and he is at a loss to understand why.—(Y. B. 1909.)

Picking.—The marketing of the fruit begins with the picking. This is the first step in selling it. No matter how carefully other details are attended to, the picking must be done properly or the price of the fruit will be greatly reduced. Fruit that has become too ripe or that has been roughly handled in picking must be sold at a reduced price, and often is altogether unsalable. To secure the highest prices the picking must be by hand, be done at the right time, and with the greatest care.

The precise time to pick fruit can be determined only by experience. No exact rule applying to every class of fruit can be prescribed. Strawberries are picked when they begin to turn red, and raspberries when the fruit parts readily from the stem on which it grows. Blackberries and dewberries may be gathered as soon as well colored, although the flavor is improved by allowing them to remain longer on the plants. Gooseberries are generally marketed green. Currants are allowed to color, but are not allowed to ripen, and for jelly making are generally preferred while a few berries still show some green. Cherries are usually picked as soon as well colored, depending somewhat on the variety. Plums may be picked when they are well colored; the Japanese kinds, however, color well after picking. Prunes are usually allowed to ripen on the trees, and are shaken off if to be used for drying. If to be shipped for use when fresh they are picked as soon as well colored. Pears are commonly picked as soon as full grown, and are preferably ripened in the shade. It is necessary for the distant market that pears be shipped green and allowed to ripen in transit. At Fresno, Cal., the season for Bartlett pears lasts two months, the first shipments beginning as soon as the fruit is big enough to sell. Peaches for near-by markets are picked as soon as they begin to show a slight softness and before they become mellow. For the distant market they are picked when well colored, but still hard. Summer cooking apples are generally picked as soon as large enough to use. All summer apples that are to be shipped must be picked green, as they are quite perishable when ripe. Late varieties are picked as soon as well colored and before severe frost. Apples should always be picked if they show by the windfalls that they are ripening. Winter apples generally keep best if picked a little before they are fully colored and are still firm and hard.

The stems should be left on strawberries, plums, apples, pears, currants, and cherries. If the stems are pulled out of the fruits the injury causes rotting. Fruit should seldom be shipped in the same packages as that in which it is picked, but should be sorted into other suitable packages in a cool storehouse. Other items to consider in picking fruit are: Baskets and bags for picking; trays; boxes; ladders; implement pickers for the apples; methods of keeping account of pickers and packers; grades of fruit; facing; wrapping; pressing; presses for apples in barrels; presses for pears and apples in boxes; importance of marks on fruit packages; importance of keeping fruit up to grade; methods of shipping and selling; local peddling; commission dealers and associations.—(U. S. E. S. B. 178.)

Mechanical Injuries.—It is generally recognized by all growers that fruit must be handled with great care if it is to be kept sound. The work of the Bureau of Plant Industry has shown that the more common kinds of molds which cause decay in transit and storage have not the power to penetrate the unbroken, normal skin of the fruit. It has been shown that the molds generally gain entrance through mechanical bruises or abrasions of the skin made in handling of the fruit in preparing it for market. Some common forms of such injuries are bruises and scratches made in the picking of the fruit, in squeezing it and dropping it roughly into picking boxes, bags, baskets, or pails, or in pouring it from the field bag or pail into boxes. Hauling on springless wagons (sleds are sometimes used) may seriously bruise the fruit. Dirt, gravel, dried branches, or twigs in the bottom of the field boxes are also a frequent source of injury. Injuries of these types are not only difficult to detect but offer ideal conditions for the starting of decay. Many fruits are injured by scratches made by the finger nails of pickers and packers. The carefully handled fruits have a great market advantage aside from their better and sounder condition, in that they are in fit shape to be reshipped from large centers to smaller surrounding towns, thus allowing a much wider distribution and extension of the market. The importance of this fact can best be appreciated when considered in connection with the problems of overproduction and the possibilities of increasing the sale and use of the fruit. As long as the commercial packs continue to arrive at or near the limit of decay commercially allowable, the possibilities of reshipment are extremely limited, and the market for the fruit is cut down accordingly.—(Y. B. 1909.)

Packing.—Containers for fruits are many and varied, and the shipper should be familiar with them all. In some of the older fruit sections it is customary to have the boxes for small fruits returned to the packer. This is a poor practice, as it results in the use of unsightly packages which affect the appearance and injure the sale of the fruit. The common experience of the best fruit growers is in favor of the gift package for general marketing. For distant shipments the return package is out of the question. The various packages used in shipping fruits, with their dimensions and costs, are given in the following table from Waugh:

Fruit.	Package.	Cost.
Apple	Barrel, 100 quarts or 3 bushels	$25 per 100.
	Box, various sizes	Variable.
	Slat crate, mostly half bushel	$4.50 per 100.
	Basket, mostly bushel	$1 to $1.25 per dozen.
Peach	Delaware basket	$2 to $3 per 100.
	Michigan basket, 1/5 bushel	$3 per 100.
	Six-basket carrier	$7 to $10 per 100.
Pear	Barrel, 3 bushels	$25 per 100.
	Half barrel, 1½ bushels	$15 to $20 per 100.
	Boxes and baskets, various kinds	
Plum and grape	Grape basket, 10 pounds	$2.50 per 100.
	Six-basket carrier	$7 to $10 per 100.
Cherry	Strawberry quart boxes and crates.	Quart boxes, $2 to $3 per 1,000; 16-quart crates, $5 to $6 per 100.
	5-pound grape baskets	
Quince	Slat crate, 1/3 bushel	$3 per 100.
	Slat crate, ½ bushel	$4.50 per 100.
	Slat crate, 1 bushel	$7 per 100.
	Baskets in various styles	
	Also barrels	
Berries	Quart boxes in crates	Quart boxes, $2 to $3 per 1,000; 16-quart crates, $5 to $6 per 100; 24-quart crates, $7 to $15 per 100.
	24-quart cases with boxes, gift	$0.16 to $0.18 each.
	24-pint cases with boxes, gift	$0.14 to $0.16 each.

—(U. S. E. S. B. 178.)

Harvesting and Marketing of Small Fruits.—Before the fruit begins to ripen, the size and style of package to be used should be decided on and a sufficient supply to market at least half of the estimated crop should be provided. The demands of different markets vary greatly, but in all of them a neat, clean package will outsell a poorly made or filthy one. The essentials are: (1) that the packages shall be of the standard size in the markets to be supplied; (2) that they be as light as may be without sacrifice of sufficient stiffness and strength to withstand any ordinary pressure; (3) that they be neat, clean, and attractive in appearance. For the small fruits, except the red raspberries, the quart box or basket (packed in crates containing 16 to 64) is the supposed standard package in most markets, though degenerate sizes and forms of this cause a variation of 25 to 30 per cent in its actual capacity. Red raspberries are commonly marketed in pint cups or boxes (packed in crates), while currants are frequently sold in the climax baskets so largely used in shipping grapes.

Where a home trade is supplied, the same packages, if carefully handled, can be used several times, but for shipment to any considerable distance the "gift" package seems destined to soon supplant the old "return" crate.

With packages provided, the necessity for some sort of packing house arises. This should be near the berries, and should be large enough to comfortably accommodate the packers and to shelter from sun and rain such quantity of picked fruit as is likely to accumulate at any one time. A flat-roofed shed, open to the north and boarded down from the top to near the ground on the other three sides, answers a very useful purpose. If a large area is planted, a more expensive building, with storage room above for packages, may be built with profit.

Enough hand carriers should be provided, so that each picker may deliver his load, receive credit for it by means of tickets or other simple method of keeping account, and receive an empty carrier in return without waiting for his own to be emptied. Some distinguishing mark should be placed upon each loaded carrier, however, in order that it may be traced to the picker at any time previous to the packing of the fruit in the crate. This is easily done by assigning to each picker a number and affixing to each carrier as it comes in an inexpensive tag marked with the picker's number. Inexperienced pickers need instruction when first placed at work, and watchful supervision for a day or two. Old hands often have to unlearn careless or slovenly habits acquired elsewhere, and in this respect are less satisfactory than new help. Neatness, thoroughness, and honesty must be insisted on, and after a picker is known to be reliable on these points his services are worth considerably more to the grower than before. Pickers should be instructed to assort fruit as they pick, or at least should be prohibited from placing decayed, unripe, or imperfect berries in the boxes with marketable fruit. All boxes should be as full as they can be packed in the crates without bruising the fruit, and the berries in the top layers should be placed by hand, so as to present an attractive appearance. It goes without saying that the fruit should be of uniform quality throughout the package if the grower hopes to build up a desirable reputation in his market.

Every package should be branded with his name, and this should be a sufficient guarantee of the uniformity of its contents. Such a brand will often insure against loss during gluts, and cause prompt sales at advanced prices when the conditions affecting demand and supply are normal.—(Y. B. Reissue 1905.)

Local Peddling.—Local peddling is only possible where the grower lives near his customers and, where practicable, it is a very satisfactory way of disposing of the product. A variety of fruits can be carried and disposed of in this way, and besides it gives opportunity to combine truck growing with fruit growing. The large grower must find some one to sell his produce. It may be best for him to sell through a commission merchant. If the grower concludes to sell in this way it is of extreme importance that the commission house that he sells to be honest. Before selecting your dealer make careful inquiry respecting his character and responsibility. The usual commission for handling fruit is 10 per cent of the gross sales. —(U. S. E. S. B. 178.)

FRUIT GROWERS' ASSOCIATIONS.

The growing of fruit itself is an intricate business and is usually all that one man should attempt. If he makes a success of orcharding, the time of the average man will be fully occupied. Then he can afford neither the time nor money to keep posted on the conditions of the markets every day, or to become acquainted with the many intricacies incident to marketing.

An association, on the other hand, can afford many of these things, because of the volume of business involved. For instance, the manager must have daily telegraphic reports on the condition of the markets; he often has a personal acquaintance with the buyers, and he finds it to his advantage to make occasional trips for the purpose, even to distant states. He can also have a system of diverting cars after they have been sent out of the State and thus avoid a glutted market, or send his fruit where it will sell to better advantage than where it was first planned. The icing of the cars can also be properly looked after. Associations are often the means of getting lower freight rates, because the hauling of several hundred cars is an item worth competing for, and in a number of instances, the managers have been successful in getting rates changed to their advantage. Such rates are, of course, open to all shippers. Buyers often want a number of car loads of a certain variety and are willing to pay a premium if their wants can be supplied, and not infrequently such sales are the means of disposing of large amounts of the inferior varieties or grades. An individual is seldom in a position to take advantage of such opportunities. Associations are successful in maintaining a uniform pack, and by this means they establish a reputation for their goods. Usually the best grades of fruit are sold as a certain brand. The brand, which should be copyrighted, is sufficient guarantee for the quality, or, at least, it must be if the association expects to gain and hold a reputation.

Supplies of various kinds which are used on fruit farms, may be bought at wholesale, often in car load lots, which is quite an advantage, especially in such items as spray and box materials. The saving which the association makes to the growers in this way is no small item, as everything is bought at wholesale. The prices to growers are only slightly in excess of actual cost. And then it is advantageous to keep a certain amount of the better class of help from year to year and to furnish them with employment, so a more or less extensive jobbing business may be carried on. It will be noticed that not only is a large amount of fruit growers' supplies handled, but a wholesale business in other lines may be done, depending upon the demands of the locality.

And, finally, an association can be handled more economically than it is possible for most individuals to market their fruit, unless they depend entirely upon the traveling buyer, or resort to the doubtful expedient of consigning to commission men.

Given a capable manager and a wise board of directors, there can be but small chance of failure. But men who are capable of handling 500 to 1,500 cars of fruit at a good profit are not common, and when one is found, every effort should be made to retain him. One of the first things that should be done for the manager, when a capable one is found, is to give him a salary in proportion to the amount of business done and the responsibility which must be carried. The latter item is certainly important when we consider that he may be responsible for a number of car loads of a very perishable product, which are on the road at once. Then, too much supervision on the part of the board of directors, who usually have small knowledge of the business, only hampers the manager and restricts his personality. If he cannot make a success of the association in his own way, the advice or help of the directors will be of little use. A much better plan is to give the manager a fair chance to work out his own ideas, and then if he fails, try another. But here is the cause of most of the failures; too much supervision by the directors and unjust criticism and fault-finding on the part of the stockholders.

A common source of discontent is the rumor that a neighbor in another association has received a higher price for his produce, or that an outside buyer is offering attractive prices. Unscrupulous firms frequently adopt the latter method of getting consignments only to swindle the grower. If there was not some decided advantage in buying direct from the growers, these firms would not go to the expense of maintaining an agent in the field when just as good or better fruit could be had from the association.

The association idea is no longer an experiment, and when each one does his share to maintain the reputation of the fruit, and the volume of business is sufficient to pay expenses, there is small chance of failure. The history of associations, the country over, shows that petty jealousies and distrust on the part of the members is the common cause of failure. One writer has summed up the subject in the following terse sentences:

"All classes of farmers are constitutionally and proverbially distrustful of other people and of one another. In a fruit association there arise (such is the experience) the most inveterate jealousies. Each man thinks he is furnishing a better grade of fruit than his neighbor, though all share alike in the profits. Each one fears the other will reap some special advantage somewhow. In particular, the appointment of managers, superintendents, supervisors of grading, shipping agents, and all other officials of the company, offers a sufficient opportunity for the elaboration of all sorts of neighborhood quarrels. Each man thinks he ought to be manager, and when one man is finally chosen he is usually suspected of all sorts of favoritism. In any case he is apt to be hampered in his business relations by committees, boards of directors, and various kinds of red tape and foolishness. Often he has to consult a committee before taking any important action. * * *

"Another difficulty which arises from the same cause is that subscribers to such an association never want to pay a manager's wages. Two or three dollars a day is considered good pay. Yet such a man is compelled at times to handle thousands of dollars' worth of business. The position is such as, in ordinary business life, would command a salary of five thousand dollars a year or more."—(Waugh, Fruit Harvesting, Storing, Marketing.)

Growers who are not members may ship through the association on the same terms, but they are usually required to pay more for supplies. All of the larger concerns require both members and non-members, for whom they ship, to bring all their fruit to the association. Formerly stockholders were allowed to sell their own fruit by paying the association a small premium. Neither were objections made to members filling orders from near-by towns. But, as these means of disposing of fruit are manifestly unfair to a majority of the association members, they have come to be looked upon with disfavor and in most instances are no longer allowed.

One of the strong points in favor of the association idea is the possibility of a fairly uniform pack. This results in better prices, since buyers have the assurance that all associations strive to make their goods as nearly uniform as possible. Then, contrary to the idea often advanced that poor fruit brings as great a price as good, the most rigid grading must be practiced, and the intention is to place each fruit in its proper grade, thus only the best grade sells for the highest price, and, indeed, the grower of inferior fruit is fortunate to dispose of his crop at all.

There are two methods of packing and grading fruit; in one instance, the association does all the packing, the growers delivering the fruit to the packing house just as it is taken from the trees. Here the packers, under the direction of a superintendent, sort the fruit into the various grades, and at the same time pack it into boxes or crates. Should there be any culls, they are returned to the grower and are at his disposal. Each grower is given a number, which is used to designate his fruit throughout the season. As each box is packed, it is marked with his number and the grade. When the boxes are loaded into the cars, the number of boxes, the varieties and the various grades which belong to any grower are kept account of and duly recorded. In this way the price for each box of fruit in any car is easily determined.

But where there is a very large amount of fruit to be handled it is impossible for the association to do the packing, consequently the growers assume this work. With this arrangement, the association employs an inspector, whose duty it is to inspect each load as it is delivered. This he does by opening the boxes on the side, in the case of apples, when a good estimate of the contents may be made. If the pack is satisfactory, not more than two boxes may be opened. If unsatisfactory, several may be examined, and if all run under the inspector's standard, the entire load must either be placed in a lower grade or else be repacked.

It will be seen that a great deal depends on the inspector, and that it is a difficult position to fill. Upon him depends the reputation of the association, so he must be entirely free to do the work as he sees fit. Each man's fruit is kept track of by numbers, as in the former case.

Most of the associations have now adopted the latter system, although nearly all have tried the former. The ideal method is, no doubt, to have all packing done at a central building, but a limit to the amount of fruit which can be handled is soon reached. It is found difficult in practice to keep track of a large number of packers at a central point, and careless work is the result. But when each grower looks after his own packing, he has a wholesome respect for the decision of the inspector. It is very expensive to repack a lot of fruit, and if he is obliged to do this, or else let it be sold as a lower grade, even on a single load, it usually results in greater pains being taken in the future. But with the best of systems, poorly packed fruit will occasionally find its way to market.

The association charges a commission on all sales, usually five per cent, to defray expenses. Then, in case the packing is done by the association, an additional charge is made to cover the cost of the box and packing. Any surplus is, of course, distributed as premiums. Any fruit grower may become a member of the association so long as there is stock for sale, and the owner of one share is entitled to all of its privileges. The number of shares one individual may own is limited.

The growers are generally asked and, in many instances, required to furnish an estimate of their crop. In the smaller associations, the manager sometimes secures this information by visiting the orchard in person. This estimate is made early in the fall, or not until damage by worms and other causes is practically over and the crop is secure. With this knowledge in hand, the manager can enter into contracts for delivering certain amounts of various varieties or grades.

The system of selling has been radically changed within the past few years. Formerly practically all of the fruit was consigned to commission men, who, as a class, it may be truthfully said, are inclined to do the best they can by their constituents. But too often the experience has been otherwise. Not infrequently has it happened that shipments consigned to a distant city have been reported as not being up to grade, or not in good condition, so the market price could not be realized. In such cases, though the manager may be certain that his fruit is as he represented, he is often unable to help himself, so must take what he can get. But of late years, the plan of selling F. O. B. is being practiced more and more, and this is largely due to the organized efforts of the associations. Consignments are only made to well known firms, and much of this fruit is sold at auction. But even with this arrangement difficulties arise, so in order to protect themselves, the larger associations have an agent at the more important distributing points. It is the duty of the agent, or broker, to inspect all cars which come into his territory, as near the destination as possible, and thus protect the association from dishonest buyers. He also is on hand to adjust the differences which arise when the fruit actually reaches the buyer in poor condition.

Express shipments are only made to comparatively near-by points, and with such shipments, the growers receive exactly what the fruit brings less the expressage and the association's commission. It is usually the early fruits that are expressed, but prohibitive rates prevent any very large amount of business being done in this way. An association, well managed, is always a benefit to the entire community, in that it builds up a reputation for the fruit, and holds up prices, inasmuch as there is not that tendency, even among non-members, to bid one against another in marketing.

In addition to this, it may be said that the managers are constantly insisting on the necessity of growing better fruit, and so have been instrumental in introducing new and improved methods of culture.—(Colo. E. S. B. 122.)

Cold Storage Warehouse Business.—During the past twenty years the commercial fruit business has developed a system of warehouses cooled by mechanical methods of refrigeration. These warehouses are sometimes operated as independent fruit-storage plants, but more often the storage of the fruit is a department of a general cold-storage warehouse business. The storage of apples in mechanically cooled warehouses has developed largely since 1890, though there has been a gradual evolution in ice making and in the application of ice to the preservation of fruits and vegetables, from the simple methods of the ancients in India, who produced ice by the evapoartion of water exposed to the night air in shallow, porous vessels, to the highly developed ice-making machines that cool the warehouses of the present day. As soon as it was found that apples could be kept satisfactorily in mechanically cooled warehouses, the application of the warehouse system to the commercial fruit industry was quickly perceived, and, in connection with the recent rapid development of the apple industry, warehouses for the cold storage of fruit have been constructed in nearly every large city and in many of the smaller towns in the apple belts.

Relation of the Warehouseman to the Fruit Storer.—The cold-storage warehouse business has developed so rapidly that the relation of the warehouseman to the man who stores the fruit, as well as the function of the warehouse in the preservation of the fruit, is not generally understood. The warehouse is supposed to supply a uniform temperature of the desired degree of cold through its rooms during the storage season. It is expected to be managed in other respects so that the deterioration of the fruit and losses from any other cause may not be reasonably attributed to a poor construction or installation of the plant, to its negligent or improper management, or to the ill-treatment of the goods within the warehouse.

If the temperature of the rooms fluctuates unduly from the degree to be maintained and the fruit is frozen to a point of injury, if it ripens with abnormal rapidity, if it is piled in certain parts of a room so that it is injured by overcooling or by heating, or if the management of the warehouse or treatment of the fruit in other respects can be shown to have been faulty or negligent, the storage house has failed to perform its proper function.

The warehouse treatment is not supposed to insure the fruit against the natural deterioration that may take place in cool temperatures. The warehouseman holds the fruit in storage as a trustee for the storer, and in that relation is bound to exercise only that degree of care and diligence in the management of the building and its contents that a man of ordinary care and prudence would exercise under the circumstances in protecting the plant and the goods if they were his private property.—(Y. B. 1903.)

Principles of Mechanical Refrigeration.—In principle, mechanical refrigeration is simple. To cool a substance to a definite temperature and hold it there, it is necessary to absorb from it the surplus heat which it contains and then to protect it against the absorption of additional heat from outside sources. As the expansion of all substances, whether in solid, liquid, or gaseous form, is accompanied by the absorption of heat, it is only necessary that some material in the act of expanding shall be in proximity to the object to be chilled. Many different materials have been tried at different times for this purpose. Several are still in practical use, but for the refrigeration of large chambers those most generally adopted at present are certain gases, particularly anhydrous ammonia and carbon anhydride. These are capable of being greatly reduced in volume by compression by steam power into cylinders, even to liquid form, and can then be safely shipped long distances to the points where they are needed. When admitted to pipes in the building to be refrigerated these gases expand and withdraw heat from the air of the surrounding chambers and from the articles stored therein. After traversing a system of pipes the gas is relieved of its heat by being compressed in a steam pump and passed through a condenser of pipe over which cool water flows. The water, in fact, carries off the heat which the gas has absorbed from the materials in storage, while the gas, reduced to its liquid form, is available for repeating the process. In some instances the expansion pipes are placed directly in the rooms to be refrigerated, in which case the system is technically known as a "direct-expansion" system. In others they are immersed in tanks of brine, which, when sufficiently chilled, is circulated through refrigerating pipes in the cool chambers by means of pumps. The latter method is known as the "brine" system.

If a perfect insulation could be devised, a properly constructed storage room, when once freed of its heat and sealed, could be held at a uniform temperature indefinitely without further attention or expenditure, but as no perfect nonconductor of heat has been found, a continuation of the cooling process is necessary. In plants properly constructed and managed, equipped with duplicate machinery to provide against break downs, it is now possible to maintain definite temperatures for long periods with very slight variation, after the initial heat of the stored product has been absorbed and removed. It is this feature which gives these systems their special value in holding fruits and other perishable products.—(Y. B. 1900.)

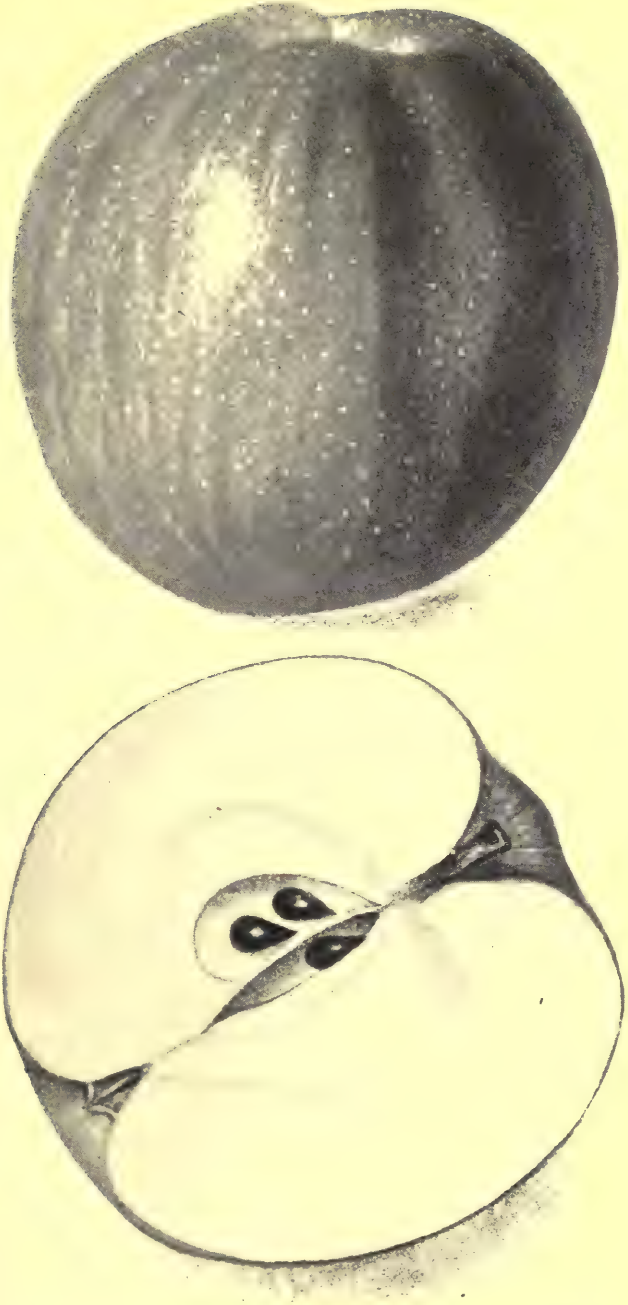
Refrigeration.—A factor of prime importance in the successful shipping of fresh fruits long distances is quick and efficient refrigeration. The deciduous fruits are all shipped during warm weather and must be kept cool while in transit. The ripening processes are hastened when the fruit is picked. The development of molds also goes on at a rapid rate while the fruit is warm. Reducing the temperature retards the ripening and prevents the development of the molds. The length of time that the fruit will remain in good condition depends upon the promptness and the thoroughness with which it is cooled.

Careful records made of many deciduous-fruit packages show that the temperatures of the packed fruit during the greater part of the season are extremely high. The range runs from 80° to over 100° F., and the average of all temperature records made is between 90° and 95° F. At such temperatures the fruit ripens very fast and decay and deterioration are extremely rapid, especially if the fruit has been roughly handled and injured to any great extent.

Records made in refrigerator cars show that the rate of cooling in the fruit package is very slow when the ice of the car is depended upon both to reduce the temperature and to hold it low. It frequently happens that several days elapse before the fruit is cooled sufficiently to retard ripening and decay. This is the main reason why the Pacific Coast fruits are picked so long before they have acquired full quality. When they are not picked green, they become over-ripe and soften before the ice of the car has a chance to reduce the temperature below the danger point.

Frequently a very distinct advantage may be gained by allowing the fruit to remain open overnight and packing while it is cool in the morning. More cooling can usually be obtained in this way than in one or two days in the refrigerator cars after the fruit is packed, especially where it is wrapped in paper. This is particularly true for grapes, and many growers and packers take advantage of it.

Precooling is usually done by mechanical means after the fruit is packed, either in a warehouse or a cold-storage plant before loading on the cars or after loading by forcing large volumes of very cold air through the cars, thus reducing the temperature of the fruit much



D.G. Passmore

Mother Apple

more rapidly than can be done with ice alone. Precooling may also be done before packing, and when this is practicable it is comparatively easy, because there is a chance for the circulation of the air around the fruit. The disadvantage of such a system is that the packing has to be done in cool rooms to avoid the condensation of moisture on the cold fruit.

The best system of precooling, whether in cars or in warehouses, has not been definitely determined, although two of the great transportation companies of the Pacific Coast are erecting mammoth plants to precool in the cars all the fruit shipped over their lines. One great disadvantage of this system is the delay which must necessarily ensue in assembling the cars from the different districts. Much of the beneficial effect from precooling will be lost unless the work is done as soon as possible after the fruit is packed. A delay of even twelve hours during warm weather may very seriously affect the results.

Another disadvantage in car precooling is the great difficulty or impossibility of so distributing the air that every package will be reached. Under the best conditions some of the packages will be cooled very much more quickly than others, depending upon the method of applying the air.

Precooling in a warehouse or cool room consists in placing the fruit in a refrigerated room, with sufficient piping to keep the room temperature well below the desired point until all the packages are thoroughly cooled. The packages may be so stacked that a thorough circulation is possible, resulting in greater uniformity in the cooling than is the case in the closely packed car.

One disadvantage of having the precooling done in warehouses is the expense of building and maintaining the necessary plants, and this must be borne by the shipping companies, growers' associations, or individual growers. Under this system the expense and responsibility fall on the shipper, while under the car-precooling system the transportation companies bear the burden. However, the transportation companies must require that the fruit be delivered to them in sound condition and fit for shipment, and whether the placing of the packages in proper condition for safe shipment should include the reduction to a proper and safe temperature is an open question.

The advantages of precooling in the handling of deciduous fruits are manifold. The first and most important of these is the fact that, if precooled, the fruit may be left on the trees to attain a greater degree of maturity, thus assuring a much better quality. It has been shown that the soft fruits, like plums, peaches, and apricots, may be allowed to remain until they reach a hard-ripe condition and may then be shipped long distances without deterioration. In the case of cherries and berries, precooling will enable the crop to be shipped greater distances, thus assuring wider market distribution and more satisfactory condition on arrival.

Precooling is now recognized as one of the important factors in the safe shipping and handling of highly perishable products, and its use will be extended as its advantages and application are better understood. It should never be used as a means to overcome difficulties arising from improper or rough handling. Used as a means to insure safe shipment after the grower and packer have done their share, precooling is both valuable and legitimate. Used as a means to overcome the effects of rough handling, precooling only retards decay and deterioration for a time, and the troubles develop when the fruit warms up after arrival in the market.—(Y. B. 1910.)

Cold Storage of Small Fruits.—Cold storage has not exerted so important an influence upon the development of the small-fruit business as upon the growing of apples, pears, and other tree fruits. Small fruits are not adapted to keeping for any length of time in cold storage. Most of the small fruits are held in cold storage to protect them from decay, usually not more than two or three days, until they can be placed in the hands of the consumer.

Nevertheless cold storage is a factor of no small importance in the handling of the small-fruit crop. Shipments of small fruits reaching destination too late for the early morning market are usually placed in cold storage until the following morning. Large quantities of small fruits are stored for two or three days when the markets are glutted and when prospects are good for an advance in prices. Many canneries are equipped with cold storage plants for use in preserving berries and other fruits until they can be utilized. In some sections small farm storage houses are used in connection with the handling of small fruits. Small fruits are sometimes stored in a frozen condition for weeks and even months for use by confectioners, bakers, and restauranteurs. Berries grown to a large size upon low, moist soil usually begin to break down more quickly in cold storage than the same varieties grown to a somewhat smaller size upon light, dry soil. Berries ripening during a period when the supply of moisture is favorable for a sound, healthy development of fruit keep better than the same varieties stunted by drought or overgrown on account of excessive rainfall. Small fruits designed for cold storage should be picked when well matured and fully colored but while still firm. There is no apparent difference in the keeping of small fruits from early, medium, and late pickings. Small fruits must be handled quickly and with great care in the field and on the way to the storage house to prevent ripening, the bruising of the fruit, and the development of mold. If the fruit is to be stored for two or three days, a temperature of 36° to 40° F. will ordinarily give satisfactory results, though a temperature of 32° F. is to be preferred. If the storage period extends over a week or more, a temperature of 30° to 32° F. will be found more effective. When frozen for long keeping, small fruits are usually subjected to a temperature of 5° to 12° F. Frozen strawberries to be used in ice cream have been in use in a limited way by confectioners for some time, while frozen raspberries, currants, blackberries, huckleberries, and other small fruits are now used successfully for pies and other pastries by a few restauranteurs and bakers.

Strawberries and raspberries were stored in close paper cartons lined with paraffined cardboard. Some of these cartons were made extra tight by the use of a paraffined paper wrap placed over the cardboard liner of the carton. The cartons without the extra wrap preserved the fruit in good, sound condition, freer from mold and tainted less by storage-house odors than fruit stored in open packages. With the extra wrap the cartons proved too tight; the fruit softened and had the characteristic bad flavor of fruit confined in an atmosphere of carbon dioxid. Wrapping baskets of berries in thin impervious paper aids materially in retaining the bright color and attractive appearance of the fruit, prevents the absorption of storage-house odors to a marked degree, and retards to some extent the appearance of mold. Strawberries were kept in good condition in cold storage from one to two weeks; red raspberries, two to three days; black raspberries, three to five days; blackberries and dewberries, from a week to ten days, and currants, two to three weeks. Cranberries kept all winter. Strawberries, raspberries, and blackberries, which have been stored for several days usually begin to break down within ten to twelve hours after removal from storage, while currants and gooseberries hold up from twelve to twenty-four hours longer. Upon removal from cold storage small fruits should be placed in the hands of the consumers as soon as possible.—(B. P. I. B. 108.)

Storing Fruit—Pointers.—The importance of being able to store fruit successfully is that: (*a*) It tends to prevent gluts in the market; (*b*) it gives opportunity to get far better prices; (*c*) it gives stability to prices; (*d*) it gives a chance to distribute the labors of marketing over longer time.

The essentials of fruit storing are as follows: (*a*) The fruit must be of good quality and have been carefully handled. It will seldom pay to store poor fruit. (*b*) Every grower should have facilities for keeping fruit for a short time. This may consist of cellars, caves, or sheds with double walls. (*c*) Ventilation and temperature are the chief points to consider in keeping storage quarters at their best. Ice may sometimes be used to advantage in reducing temperature. (*d*) Whether the grower should own his storage house or use commercial cold storage is a point that should be carefully considered by every fruit grower. (*e*) The varieties which keep well in cold storage should be carefully considered by those who expect to store their fruit, as there is a great difference in their keeping qualities.—(U. S. E. S. B. 178.)

BOTANY OF CULTIVATED FRUIT PLANTS.

Buds of Fruit Plants.—Buds are generally formed at the nodes and in the axils of leaves, but may also develop under certain conditions anywhere on the stem or root. Plums, cherries, raspberries, and blackberries thus develop buds when cut back or injured. The fruit buds of apples, pears, and European plums are usually produced on short spurs at least two years old. The peach fruit buds are borne only on the new growth formed the preceding season. Fruit buds are usually larger than leaf buds. With orchard fruits they are formed during late summer and early fall, and with a little practice can be readily distinguished in winter. In most cases the embryo flower within the bud can be seen with the naked eye.

The proper development of the fruit bud is influenced by factors which are brought to bear upon the tree prior to and during the period at which fruit-bud formation takes place. In the practice of such orchard operations as are designed to influence or control fruit-bud formation, it appears that such operations should be more effective in the spring and early summer than at other stages of development.—(U. S. E. S. B. 178; Va. E. S. R. 1910.)

Leaves of Fruit Plants.—An abundance of healthy leaves is essential to the rapid growth of the tree and the regular development of fruit. The leaves combine and elaborate the crude sap from the soil and the carbon dioxid of the air into new compounds suitable for wood growth and fruit. Spraying, even in years of unfruitfulness, is often of advantage because it permits the maturing of a full crop of healthy leaves.

Fruit.—A true fruit, strictly speaking, is the ripened seed vessel and its contents. This agrees with the horticulturist's definition of such fruits as apples, pears, peaches, apricots, plums, gooseberries, and currants, but in the case of strawberries, blackberries, and mulberries it would permit only the single grains on the sides of the berries to be called fruits, whereas the fleshy center is the part referred to by the fruit grower when he speaks of them as fruits.—(U. S. E. S. B. 178.)

Flower.—The time of flowering in the spring of a given variety of fruit, is dependent upon a number of causes or conditions, chief among them being, first, the number of positive temperature units received in the spring preparatory to flowering; second, the stage of development of the flower-buds as dependent upon the climatic conditions of the summer and fall preceding the flowering; third, the fruiting of the trees,—whether light or heavy the year previous to flowering; fourth, soil conditions and the amount of plant food present in the soil; and fifth, the individual characteristics and state of health of the tree or plant.

From the data presented it would appear that there is but little relationship between the time of flowering and the temperature in the spring, up to the time of flowering, while there appears to be considerable evidence that the temperature and other climatic conditions during summer and fall preceding flowering has much to do with the time of flowering.

As a general statement, it is true that a given variety of fruit trees will flower when it has received a reasonable number of temperature units, but it is also true that this number is not constant, but rather variable, and on this account cannot be used in formulating a physiological constant.

On the other hand, there are greater reasons for constructing a physiological constant from the sum of positive temperature units received during the summer, fall, and spring preceding the life event, though, as has been stated, other factors enter into the calculation. But, eliminating these factors, it seems reasonable from the evidence presented, a physiological constant can be formulated from the climatic conditions during the ten months preceding the time of flowering.—(U. S. E. S. B. 178; Wis. E. S. B. 137.)

POLLINATION IN ORCHARDS.

Various Reasons Why Flowers Do Not Set.—Fruit-growers have seen trees which blossom full, but do not set a fair amount of fruit; many have found their orchards unprofitable for this reason. It is a practical point to know the causes of this loss and the best way to prevent it. In the first place, but a small percentage of the blossoms set fruit, even in the most favorable seasons and with the most productive varieties. In blossoming time a Japanese plum tree is a mass of white, carrying scores of flowers on a single branch; yet scarcely a dozen fruits may set on that twig, and some of those must be removed or the tree will over-bear. The normal failure in the setting of fruit blossoms may be due to a number of causes; as poorly nourished fruit-buds, lack of pollination, or winter injury to the pistils which cannot be seen with the eye alone. It is usually a distinct advantage to the fruit-grower, as it saves thinning.

The wholesale failure in the setting of fruit is often called self-sterility. It must have other varieties near it in order to bear well. But it appears that self-sterility in orchard fruits is often confused with the unfruitfulness resulting from other causes. The influences which sometimes make trees unfruitful, which are often confused with the unfruitfulness resulting from self-sterility, are (1) heavy wood growth, (2) the attack of fungi on the blossoms, (3) frosts, (4) unfavorable weather during the blooming season. It should also be said that a tree is not self-sterile when it does not blossom. Why trees do not bloom is generally due to poor management.

Blossoms May Drop Because of Heavy Wood Growth.—Young trees generally set little or no fruit the first few years, when they are growing fast, although they may blossom full. With most varieties this early dropping of the blossoms occurs only two or three seasons, but Northern Spy and a few other varieties of apples are often unfruitful ten to thirteen years from this cause. Older trees may show the same results if stimulated too highly with nitrogenous fertilizers. The logical remedy is to check this excessive growth of wood by withholding nitrogen or by putting the orchard into sod for a few years.

The direct cause of this unfruitfulness is not known. The stamens and pistils are usually well developed and pollen may be produced in abundance. Since young trees drop their blossoms as badly in a mixed orchard where other pollen is available, as when alone, the trouble probably lies more with the pistils than with the pollen. Up to this limit of excessive growth, there is a fairly constant relation between the vigor of a tree and its productiveness. Lack of vigor causes much more unfruitfulness than excessive vigor. If a tree is unhealthy or dying because of poor nourishment, few of its blossoms are strong enough to set fruit. The same results may follow if the tree is exhausted by over-bearing.

Blossoms May Be Killed by Fungi.—If the weather is warm and wet in early spring, conditions are favorable for the growth of fungi and it sometimes happens that fruit blossoms are "blasted" by the early growth of these parasites. Wherever spraying is practiced faithfully, the killing of fruit blossoms by fungi need not occur, especially if one thorough application is made to the trees before the buds open.

Winter and Spring Frost May Injure the Blossoms.—The unfruitfulness arising from winter or spring frost injury is sometimes confused with self-sterility. A common form of injury is that in which the pistil is blackened and stunted, having made no perceptible growth during the opening of the flower. These pistils always drop from the tree soon after the petals have fallen. Another and not less common form of injury is that in which the pistil has made a partial growth but has no well developed ovary. Unless a careful examination is made, blossoms like this would not be considered as winter-injured. The killing of the pistils is the most common form of winter injury to fruit buds.

The injury to fruit blossoms from cold is of all degrees. During the opening of a normal flower, the pistil grows. It is often taken for granted that if this growth occurs the pistil is uninjured; but it may be that even though a pistil reaches its full size, it may yet be so injured that it cannot develop into fruit. Some of the imperfect development of flowers which is attributed to winter injury may be caused by unfavorable conditions during the previous season, when the buds were being formed; yet it is likely that winter injury to pistils is more common and more serious than appears at first sight.

Rain May Injure Fruit Blossoms.—The unfruitfulness which often follows a rain during the blooming season is sometimes confused with self-sterility. A careful fruit-grower watches the weather anxiously when his trees are in blossom, for he knows this is the most critical period in the growth of the crop. Injury to fruit blossoms from rain is common wherever fruit is grown, but is particularly serious along the Pacific Coast and near the shores of the Great Lakes. It has been estimated that more fruit is lost in California from cold rains during blooming time than from all other causes combined. Like winter injury to fruit buds, there is no way of preventing this loss except to secure a more favorable location, since it is not in man's power to prevent rain.

If a rain comes while the trees are in full bloom the pollen is washed from those anthers which have already opened, and is thus prevented from reaching the stigma. Should the rain be a short one, no serious harm need result from this loss of pollen, for the unopened anthers will burst and pollination will begin again soon after the sun comes out. The washing away of pollen has very little influence in decreasing the setting of fruit, particularly when the rain is short. There will generally be enough pollen to supply the pistils before or after the rain.

The poor setting of fruit which often follows a long rain and sometimes a shower is due more to a loss of vitality in the pollen or to some mechanical injury to the pistils; also, in large measure, to the fact that bees and other insects which promote the beneficial cross-pollination between varieties are absent. If the rain lasts for several days, the pollen may lose its vitality. It is also natural to suppose that a hard rain may wash off, dilute, or otherwise injure the juices of the stigma so that the pollen cannot germinate after it falls upon the stigma. Perhaps a long "spell" of wet weather may even kill the pistils after they have been fertilized.

Thus a rain during the blooming season may decrease the setting of fruit in four ways: (1) By preventing the pollen from reaching the stigma, both because it is too wet to fly and because pollen-carrying insects are absent. This is important only when the rain lasts several days and most of the pistils pass their receptive state before the rain ceases. (2) By destroying the vitality of the pollen. (3) By injuring the stigma. (4) By preventing fertilization or the germination of the pollen because of low temperature.

The Blossoms May Be Injured by Strong or Drying Winds.—Near the sea and large lakes, fruit blossoms may be whipped off by very severe winds. In such cases a mixed windbreak of deciduous and evergreen trees may be used to advantage. Drying winds during the blossoming season are not common in the east but are often serious in some parts of the west. Luther Burbank, one of our best observers and experimenters in orchard pollination, says a dry wind sometimes causes a short fruit crop in some parts of California by drying up the juices of the stigma so that the pollen cannot germinate.

SELF-STERILITY.

There are some trees which blossom full year after year but set little or no fruit, even in the most favorable seasons. These trees are usually in solid blocks, or at a distance from any other variety. Planting near them other trees of the same variety does not make them fruitful; but if trees of other varieties are planted near they are often made fruitful. A self-sterile variety is one which is unable to set fruit when alone; in order to be productive, it must be planted near some other variety. Two varieties very commonly self-sterile are Miner and Wild Goose plums. Large blocks of the Kieffer pear and some of the great prune orchards on our Pacific Coast have been unprofitable from this cause.

In general, the cause of self-sterility is that the pollen of a variety is unable to fertilize the pistils of that same variety. That is, if pollen from a Wild Goose blossom falls on a Wild Goose pistil, whether on the same tree or any other Wild Goose tree, no fruit will result as a rule. The pollen of a self-sterile variety may be and generally is produced in abundance and is well formed. Wild Goose generally bears pollen freely, although it is one of the most self-sterile varieties in cultivation. The Bartlett pear is often self-sterile, yet its pollen is perfect. The pollen of a self-sterile variety also has vitality, for it will fertilize the pistils of other varieties. For example, plant together trees of the two self-sterile varieties, Miner and Wild Goose, and both will often be made fruitful, because the pollen of each, though infertile on itself, is fertile on the other.

The practical bearing of the self-sterility problem is this: There are certain varieties of fruit which we wish to grow largely for the general market, but we find that they are not productive when planted alone. They need the pollen of other varieties to make them fruitful. Other varieties must be planted near them as pollinizers.

Cross-pollination of varieties is no longer a theory; it is an established orchard practice.

Varieties Which Are Often Self-Sterile.—Self-sterility is not a constant character with any variety. It is influenced by the conditions under which the tree is grown, as are the size, shape and color of the fruit. The adaptation of a variety to soil and climate has much to do with its self-fertility, and if a tree is poorly nourished it is more likely to be infertile with its own pollen. No one can separate varieties of fruit into two definite classes, the self-sterile and the self-fertile. Thus Bartlett and Kieffer are often self-sterile, but there are orchards of both which are self-fertile. The same may be said of many other varieties. The best that can be done, therefore, is to give a list of those varieties which *tend* to be more or less self-sterile and which it would be unsafe to plant alone.

Following is a conservative list of these risky varieties, drawn both from experimental work and from the reports of over five hundred fruit growers: *Pears*—Angouleme (Duchess), Bartlett, Clapp, Idaho, Kieffer, Nelis. *Apples*—Bellflower, Primate, Spitzenburg, Willow Twig, Winesap. *Plums*—Coe Golden Drop, French Prune, Italian Prune, Kelsey, Marianna, Miner, Ogon, Peach Satsuma, Wild Goose, and according to Waugh and Kerr, all other varieties of native plums except Robinson. *Peach*—Susquehanna. *Apricot*—White Nicholas. *Cherries*—Napoleon, Bell de Choisy, Reine Hortense. Most of these varieties are self-fertile in some places, but the weight of evidence shows them to be uncertain.

It must not be inferred that all other varieties are always able to set fruit when planted alone. There are some, however, which have exceptionally good records for fruitfulness when planted in solid blocks, other conditions being favorable. Among these are: *Apples*—Baldwin, Ben Davis, Fallawater, Janet, Oldenburg, Rhode Island Greening, Red Astrachan, Smith Cider. *Plums*—Burbank, Bradshaw, DeSoto, Green Gage, Lombard, Robinson and some of the common blue Damsons.

The problem of self-sterility is as much a study of conditions as of varieties. We can set no limits; we can only indicate tendencies.

Selecting the Pollinizer.—There are two points to be considered when selecting a pollinizer for any self-sterile variety; these are simultaneous blooming and mutual affinity.

The first and most important point is that the two shall blossom together, since the only way in which a pollinizer can make a self-sterile variety fruitful is by supplying it with pollen. This means that the pistils of the self-sterile variety must be receptive when the stamens of the pollinizer are ripe, which is possible only with simultaneous blooming.

The comparative blooming of varieties is more or less a local problem. Differences of latitude, altitude, soil, nearness to large bodies of water, and weather conditions during the blooming season not only hasten or retard the time of blooming, but also disturb the order in which the different varieties open. Varieties blossoming together at one place may not at another. The best that can be done in the way of generalizing on the question of simultaneous blooming for cross pollination is to make a chart for each well marked geographical district. Until more definite knowledge is available, each orchardist should learn how varieties bloom in his own neighborhood before planting them for cross-pollination. It is better, but not always necessary, that the two should bloom exactly together; if they overlap two or three days that is often enough.

It is sometimes desirable to plant varieties of different botanical species together for cross-pollination, but this will often be impracticable because of the difference in their blooming seasons.

The Mutual Affinity of Varieties.—Another point to be looked after when selecting a pollinizer for any self-sterile variety, is the mutual affinity of the two. That is, will the pollen of the pollinizer fertilize the pistils of the self-sterile variety readily and also develop them into high grade fruit?

It is necessary to study not only the mutual affinity of varieties belonging to different species, but also of varieties of the same species. Some varieties will not fertilize each other, though blossoming at the same time.

Some of the combinations which have been very successful in the commercial orchards of the country are: Bartlett with Nelis, Flemish Beauty, Easter, White Doyenne, Idaho with Bartlett; Kieffer with LeConte, Garber; Coe Golden Drop with French Prune, Green Gage, Italian Prune (Fellenburg); Statsuma with Abundance, Burbank, Red June; Miner with DeSoto, Forest Rose, Wild Goose; Wild Goose with DeSoto, Newman, Miner.

Does Crossing Change the Appearance of the Fruit?—In connection with the mutual affinity of varieties which are selected for cross-pollination, there comes the question of the "immediate influence" of pollen. For instance, if Seckel pollen is put on Kieffer pistils, will it impart the Seckel flavor, color and characteristic shape to the resulting fruit? The characters of both may be united in the seeds, and the trees which come from these seeds may be expected to be intermediates; but is the flesh of the fruit ever changed by foreign pollen?

The increase in size which often follows crossing cannot be called a true immediate influence, for the foreign pollen generally stimulates the fruit to a better growth because it is more acceptable to the pistils, not because it carries over the size-character of the variety from which it came. Setting aside the usual gain in size resulting from crossing, will there be any change in the shape, color, quality and season of ripening of the fruit?

Most of the changes in fruit which are attributed to the influence of cross-pollination are due to variation. Every bud on a tree is different in some way from every other bud on that tree and may develop unusual characters, independent of all the other buds, according to the conditions under which it grows. The best way to determine whether there is an immediate influence of pollen is by hand crossing.

Most of the evidence supporting the theory that there is an immediate influence of pollen in the crosses of fruits comes from observation; most of the evidence against it comes from experiment. The observer, however careful, is likely to jump at conclusions; the experimenter tries to give due weight to every influence which might bear on the problem. Since many observers and a few experimenters have found what seems to be an immediate influence of pollen on the fruit, it cannot be doubted but that this influence is sometimes exerted. But it is certainly much less frequent than is commonly supposed.

The Distribution of the Pollinizers.—Having selected a pollinizer with reference to simultaneous blooming and mutual affinity, the fruit farmer will wish to know how many trees will be necessary to pollinate the self-sterile variety. There are three things to be considered: the ability of the pollinizer to produce pollen, its market value, and the class of fruit to which the self-sterile variety belongs.

Varieties differ in the amount of pollen which they produce, and the pollen production of the same variety is also greatly modified by differences in locality and season. Other things being equal, the variety which produces pollen freely could be used more sparingly in a block of self-sterile trees than one of scanty pollen production. As a matter of fact, most of our common varieties produce an abundance of pollen. The number of trees of the pollinizer would also depend largely on whether it has value in itself. Some growers plant every tenth row to the pollinizer, but the proportion should usually be greater. This might be enough if the weather during the blossoming season is very favorable for cross-pollination by wind and insects; but if it is showery, the pollinizers should be more abundant, in order that cross-pollination may be more general during the bright weather between showers. In a commercial orchard, the pollinizer should be planted in a solid row. Theoretically, it is much better to have the pollinizer more evenly distributed among the self-sterile trees; practically, it will not pay to so mix them except in small orchards.

Advantages of General Mixed Planting.—Cross-pollination gives better results with nearly all varieties, be they self-sterile or self-fertile. A variety may be able to bear good fruit when it is planted alone, but it will often bear better fruit if suitable varieties are near it.

Mixed orchards are more productive than solid blocks, taking the country over. It is a common observation in Western New York that Baldwins in mixed orchards are more uniformly productive than Baldwins in large blocks. Furthermore, although a variety may be able to set an abundance of fruit with its own pollen, this fruit will often be smaller than if other pollen were supplied.

The Pollen-Carriers.—The pollen of one variety is carried to the pistils of another in two ways: by the wind and by insects. There are many kinds of insects which aid more or less in the cross-pollination of orchard fruits, principally bees, wasps and flies. Of these, the wild bees of several species are probably the most important. In a wild thicket of plums or other fruits, they are usually numerous enough to insure a good setting of fruit. But few if any wild bees can live in a large orchard, especially if it is well tilled. As the extent and thoroughness of cultivation increases, the number of these natural insect aids to cross-pollination decreases; hence it may become necessary to keep domestic honey bees for this purpose.—(Cornell Ex. Sta. B. 181.)

Hybrids.—Where a cross is made between very different forms, as between the sand cherry and the plum, the result is termed a hybrid. The difference between crosses and hybrids is only one of degree, and of late years there has been a tendency to do away with the use of the term "hybrid" altogether. There is a common impression that hybrids are exceedingly rare and that they are of more value than ordinary crosses, but such is far from being the case, as they are frequently of but little value.

While wild plants come nearly "true" from seed, cultivated fruits, which have been developed from them, do not come "true," but show a decided tendency toward the wild, inferior forms. Although an occasional seedling may be a decided improvement over the cultivated kinds, there is not one chance in a thousand of getting better fruits than those we now have by growing the seeds of these better sorts. This is due to the fact that we do not grow our fruits from seed but by grafting, budding, etc. If they were grown from seed for many generations it would undoubtedly be possible to get them to come as true to type as do our garden vegetables. Since no two plants are exactly alike, it is evident that the strongest tendency in plants must be toward dissimilarity. Some cultivated fruit plants that come most nearly true from seed are a few local varieties of the peach, the Wyant plum, and such strawberries as the Alpine and St. Anthony de Padua.

The yearly round of activity of a plant is rapid growth in the spring, during which time it is using up the store of plant food accumulated the year before. After this rapid growth has passed there follows a slower period of growth, in which the wood is said to ripen; that is, it becomes hard by reason of its cells becoming filled with starch or other plant food which is stored for use in starting growth in the spring. When this storing process is completed growth stops. When there is warm, moist weather, late in autumn, growth sometimes starts again and a portion of this plant food is thereby changed into unstable compounds which, when exposed to freezing, results in winterkilling. Some varieties are much more liable to start in this way than others.—(U. S. E. S. B. 178.)

Rapid Wood Growth.—It has been often observed that trees making very rapid wood growth fail to bear heavy crops of fruit. This is well illustrated in the case of young trees which fail to bear during the first years of their growth. The reason for this is not well understood, but it is fully established that the growth and reproductive forces are in a measure alternative and that whatever favors the one will retard the other. While over-rapid growth always tends to lessen the fruitfulness of a tree, lack of food or insufficient nourishment will produce the same effect. The remedy in either case is obvious and the condition is readily corrected.—(Va. E. S. B. 155.)

CIRCULATION OF SAP IN PLANTS.

This is a complicated process that is understood in only a general way. In fruit plants that have netted veined leaves the circulation is as follows: (*a*) The crude sap comes up from the roots to the leaves through the sapwood. (*b*) In the leaves it is digested and enters into combination with the food that the leaves take from the air and is then termed "prepared sap." (*c*) The prepared sap returns to feed the plant through the cambium, which is the portion on the outside next the bark. (*d*) Girdling cuts off this return flow of sap and prevents its going to feed the tissues below.—(U. S. E. S. B. 178.)

Classification of Varieties.—It has been estimated that there are more than 10,000 varieties of cultivated fruits in America. In order to study these satisfactorily some method of classification is necessary. Botanists have found it convenient to group plants under the head of class, order, genus, and species. The same classification applies to the larger groups in horticulture, but the horticulturist goes further with his classification and divides his plants into varieties.

Variety.—A variety is made up of a group of individuals which differ from the rest of their species in certain recognizable particulars which are transmitted from generation to generation without material modification. Varieties having certain important traits in common are made into groups more or less definite by the horticulturist, as for instance, when he groups certain varieties of fruits or vegetables together, as Burbank potatoes, Winesap apples, etc.

New varieties of fruits are continually appearing. In the naming and describing of these new sorts there is chance for confusion by duplication of names. In order to simplify this the following rules have been adopted by the American Pomological Society:

Rule I. The originator or introducer (in the order named) has the prior right to bestow a name upon a new or unnamed fruit.

Rule II. The society reserves the right, in case of long, inappropriate, or otherwise objectionable names, to shorten, modify, or wholly change them when they shall occur in its discussions or reports, and also to recommend such changes for general adoption.

Rule III. The name of a fruit should preferably express as far as practicable by a single word a characteristic of the variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

Rule IV. Should the question of priority arise between different names for the same variety of fruit, other circumstances being equal, the name first publicly bestowed will be given precedence.

Rule V. To entitle a new fruit to the award or commendation of the society it must possess some valuable or desirable quality, or combination of qualities, in a higher degree than any previously known variety of its class and season.

Rule VI. A variety of fruit having been once exhibited, examined and reported upon as a new fruit by a committee of the society will not thereafter be recognized as such, so far as subsequent reports are concerned.—(U. S. E. S. B. 178.)

PROPAGATION OF FRUIT PLANTS.

With a few unimportant exceptions the cultivated fruits do not come true from seed, and hence other methods have been devised for their propagation. (*a*) The seed is used in growing stocks upon which to work such fruits as apples, pears, plums, peaches, etc. (*b*) The seed is also used in growing the varieties of plums, peaches, and strawberries that usually come true from seed, such as the Alpine and St. Anthony de Padua strawberry, the Wyant plum, and a number of local varieties of peach.

Germination.—Some of the conditions that influence the germination of seeds are as follows: (*a*) Seeds that ripen in the early summer, such as those of the strawberry, gooseberry, and raspberry, if sown at once will germinate quickly. Seedlings of such kinds should be wintered over in a cold frame, greenhouse, or cold cellar. If the seed is dried, it should be stratified over winter and be sown in the spring. (*b*) Seeds that ripen in the late summer should be stratified and sown in the late spring. (*c*) Stratification is the mixing of seeds with soil or other material and burying out of doors. It is a common and very satisfactory way of keeping the seeds of peaches, plums, apricots, and various kinds of nuts over winter. All of the hardy seeds may be treated in this way successfully. Apple seed is generally dried during winter and moistened and frozen in the spring before sowing, but may be stored by stratification with best results.

The strawberry and red raspberry, American plum, Morello cherry, and some other fruits, may be propagated by planting the sprouts that come up from the roots. Such sprouts are termed "offsets." Suckers for planting are best removed in autumn or in the spring.—(U. S. E. S. B. 178.)

Propagation by Cuttings.—Cuttings are portions of a plant removed for rooting and which develop into independent plants. (*a*) Cuttings may be made of the ripened wood of the branches in the case of the gooseberry, currant, grape, quince, and the Kieffer pear. (*b*) Cuttings may be made from roots as in case of the red raspberry, blackberry, and some kinds of cherries and plums. (*c*) Cuttings may be made from the soft summer growth of the grape, currant, and gooseberry. In the case of the strawberry, they may be made from the immature offsets. Soft wood cuttings need a frame or greenhouse for securing best results.

Size of Cuttings.—(*a*) The size of cuttings varies greatly. A single bud in each cutting is all that is required, provided the cutting is properly cared for. One-bud cuttings are frequently used in propagating the currant and grape. Both require the best of attention. (*b*) Cuttings with several buds increase their chances of living and encourage strong growth.

Conditions Necessary for the Successful Growing of Hardwood Cuttings.—For hardwood cuttings the wood should be well matured and firm. The wood should preferably be made up into cuttings in autumn or early winter, stored in a cold cellar, cave, or pit outdoors. They will often be calloused by spring if thus treated. The solar pit is a frame arranged so as to utilize the sun's heat in callousing the cuttings.

Planting Cuttings.—(*a*) The soil should be rich in plant food and sufficiently compact to hold moisture but porous enough to prevent baking. (*b*) Cuttings as a rule should be calloused before planting and be set out before they show roots. It is best to get cuttings into the ground as soon as it is in proper condition in the spring. Do not plant grape cuttings until they are calloused. Currant cuttings may be set out in early autumn. When thus treated they will often be rooted by winter. (*c*) Do not have over 1 inch of the cutting above ground, just so that the upper bud will come at the surface. (*d*) Set the cuttings at an angle of 45°. This is preferred to setting straight, as they remain more firm. (*e*) In making cuttings, plan to have at least one bud within 1 inch of the top end.—(U. S. E. S. B. 178.)

Layering.—A layer is a branch so placed in contact with the earth as to induce it to throw out roots and shoots, thus producing independent plants, the branch meanwhile remaining attached to the parent plant. Layering frequently proves a satisfactory method of multiplying woody plants which do not readily take root from cuttings.

Tip Layering.—The tip of a branch or cane is bent down to the ground and slightly covered with soil, when it will throw out roots and develop a new plant. Many plants can be propagated in this way. The black raspberry is a familiar example.

Vine Layering.—A vine is stretched along the ground and buried throughout its entire length in a shallow trench, or it may be covered in certain places, leaving the remaining portions exposed. Roots will be put forth at intervals and branches thrown up. Later the vine may be cut between these, leaving a number of independent plants. The grape can be easily propagated in this way.

Mound Layering.—Plants which stool, sending up a large number of stems or shoots from a single root, are often layered by mounding up the earth so as to cover the bases of these stems and cause them to throw out roots. Each may then be removed from the original root and treated as an independent plant. A plant is often cut back to the ground to make it send up a large number of shoots to be layered in this way.

Grafting.—Were all forms of the art of grafting and budding to be taken from the horticulturist today, commercial fruit growing in its high state of perfection would decay with the orchards now standing.

Importance of Grafting.—All the common pomaceous fruits (apples, pears, and quinces), the stone fruits (peaches, plums, cherries, and apricots), and the citrus fruits (lemons, limes, and oranges) are now multiplied by grafting or budding. The progress in plant breeding and the great rapidity with which new sorts are now disseminated could not be obtained without the aid of budding or grafting. Under existing conditions it is not necessary for the originator of a new sort of apple to give any thought to the question of fixing that type so it may be reproduced from seed; the method of reproducing the sort does not enter as a factor into his efforts to secure the desired variation. Grafting or budding has settled that long ago; but were it otherwise, horticulturists would be studying different problems, and the nursery-man would be more of a scientist than a manufacturer.

The Scion and Its Treatment.—A scion is a portion cut from a plant to be inserted upon another (or the same) plant, with the intention that it shall grow. Except for herbaceous grafting the wood for scions should be taken while in a dormant or resting condition. The time usually considered best is after the leaves have fallen, but before severe freezing begins. The scions are tied in bunches and buried in moist sand, where they will not freeze and yet will be kept cold enough to prevent growth. Good results often follow cutting scions in the spring just before or at the time the grafting is to be done. If cleft grafting is the style to be employed this practice frequently gives good results, but spring cutting of scions for whip grafting is not desirable, as not enough time is given for proper healing of the wound before planting time in the spring.

The Stock and Its Treatment.—The stock is the plant or part of a plant upon which or into which the bud or scion is inserted. For best results in grafting it is essential that the stock be in an active condition, or so that active growth can be quickly brought about.

Cleft Grafting.—This style of graft is particularly adapted to large trees when for any reason it becomes necessary to change the variety. Branches too large to be worked by other methods can be cleft grafted.

A branch 1 or 1½ inches in diameter is severed with a saw. Care should be taken that the bark be not loosened from any portion of the stub. Split the exposed end with a broad thin chisel or grafting tool. Then with a wedge or the wedge-shaped prong at the end of the grafting tool spread the cleft so that the scions may be inserted.

The scion should consist of a portion of the previous season's growth and should be long enough to have two or three buds. The lower end of the scion which is to be inserted into the cleft should be cut into the shape of a wedge, having the outer edge thicker than the other. In general, it is a good plan to cut the scion so that the lowest bud will come just at the top of this wedge so that it will be near the top of the stock. The importance of having an intimate connection between the growing tissues of both scion and stock can not be too strongly emphasized, for upon this alone the success of grafting depends. To make this contact of the growing portions doubly certain, the scion is often set at a slight angle with the stock into which it is inserted in order to cause the growing portions of the two to cross. After the scions have been set the operation of cleft grafting is completed by covering all cut surfaces with a layer of grafting wax.

Whip Grafting.—This style of grafting is the one almost universally used in root grafting. It has the advantage of being well adapted to small plants only 1 or 2 years of age, as well as the other great consideration that it can be done indoors during the comparative leisure of winter. The graft is made by cutting the stock off diagonal—one long smooth cut with a sharp knife, leaving about three-fourths of an inch of cut surface. Place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the stock in the direction of its long axis. Cut the lower end of the scion in like manner, and when the two parts are forced together the cut surfaces will fit neatly together and one will nearly cover the other if scion and stock are of the same size. A difference in diameter of the two parts to be united may be disregarded unless it be too great. After the scion and stock have been locked together they should be wrapped with five or six turns of waxed cotton to hold the parts firmly together.

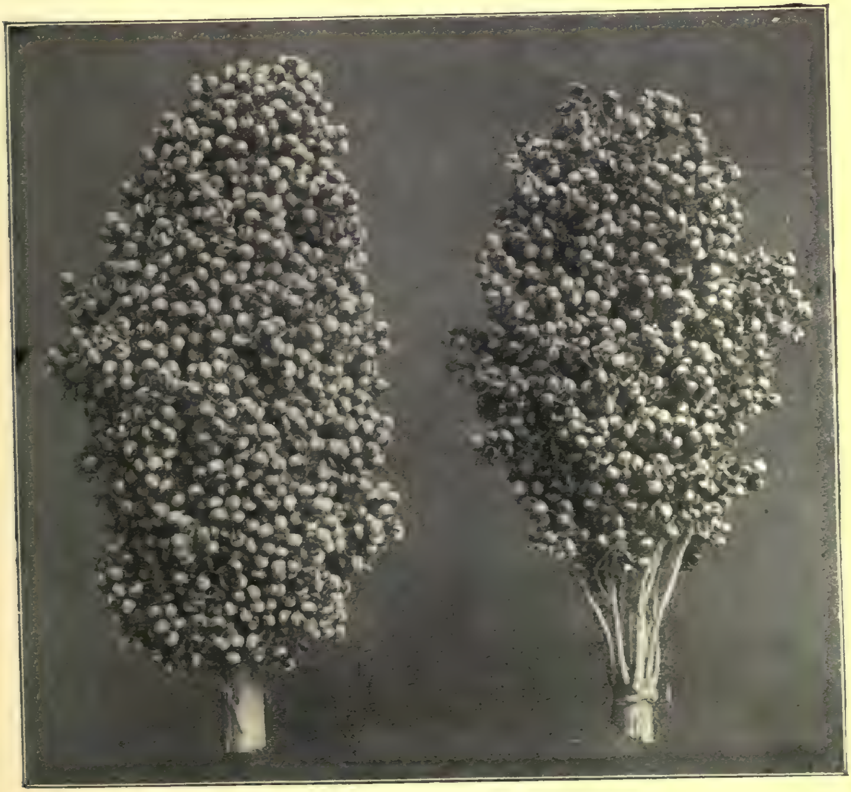
While top grafting may be done in this way, it is in root grafting that the whip graft finds its distinctive field. When the roots are cut into lengths of 2 to 5 or 6 inches to be used as stocks, the operation is known as piece-root grafting. Sometimes the entire root is used.

The roots are dug and the scions are cut in the fall and stored. The work of grafting may be done during the winter months. When the operation has been performed, the grafts are packed away in moss, sawdust, or sand in a cool cellar, to remain until spring. It is important that the place of storage should be cool, else the grafts may start into growth and be ruined, or heating and rotting may occur. If the temperature is kept low—not above 40° F.—there will be no growth except callousing, and the knitting together of stock and scion.

In ordinary propagation by means of whip grafts, the scion is cut with about three buds, and the stock is nearly as long as the scion. The graft is so planted as to bring the union of stock and scion not very far below the surface of the ground; but where the trees are required to be especially hardy in order to stand severe winters, and the roots used are not known to be so hardy as the plants from which the scions have been cut, a different plan is adopted. The scions are cut much longer and the roots may be cut shorter, and the graft is planted so deep as to cause roots to issue from the lower end of the scion. When taken up to be set in the orchard, the original root may be removed entirely, leaving nothing but the scion and the roots which have put forth from it. This is a common practice in preparing nursery stock for planting in the northern part of the Mississippi Valley.

Other Methods of Grafting.—There are a great many other methods of uniting scion and stock, a few of which may be mentioned: A branch is sawed off, as for cleft grafting, and the scions, instead of being inserted in a cleft, are cut very thin and slipped between the bark and wood, being inserted far enough to bring the growing parts together. The bark is then securely bound and wax is used as in cleft grafting. This is called crown grafting by the Eng-

Orchard in Michigan. Dept. of Agr.



Two Heads of Milo Showing Desirable and Undesirable Types. Dept. of Agr.

lish and French. It is an excellent method for grafting larger limbs, as it injures the stock less than cleft grafting.

Splice grafting is like whip grafting, except that no splitting is done, the sloping surfaces being simply placed together and tied.

Saddle grafting is cut to a wedge shape and the lower end of the scion is split and set upon the wedge, the place of union being tied and waxed.

The top of the stock is removed in veneer grafting with an abrupt slanting cut. Then beginning at the highest portion of the top of the stock, cut a shaving which is thickest at its base and which can only be removed by a sloping cut. Cut the lower end of the scion in like manner and bind the two firmly together with waxed string. When this style of graft is used as a root graft, no wax is necessary, but when used above ground the wound should be well covered. This method of grafting is adapted to use in either summer or winter.

In shield grafting the scion is cut very thin, as in bark grafting, and is inserted under the bark of the stock as a bud is inserted in the process of budding and is firmly bound in place with waxed cord or raffia. The scion is cut wedge-shaped in side grafting as for cleft grafting, a chisel or a thick knife blade is forced into the stock, and the wedge of the scion is then forced into the incision. Waxed string and wax are then used.

Grafting Wax.—A good grafting wax may be made of the following ingredients: Resin, 4 parts; beeswax, 2 parts; tallow or linseed oil, 1 part—by weight. If a harder wax is needed, 5 parts of resin and 2½ of beeswax may be used with 1 part of tallow. The resin and beeswax should be broken up fine and melted together with the tallow. When thoroughly melted the liquid should be poured into a vessel of cold water. As soon as it becomes hard enough to handle it should be taken out and pulled and worked until it becomes tough and has the color of very light-colored manila paper. If the wax is applied by hand, the hands should be well greased, tallow being the best material for this purpose. The wax may be applied hot with a brush, but care is necessary in order to avoid injury. The wax should be spread carefully over all cut or exposed surfaces and pressed closely, so that upon cooling it will form a sleek coating impenetrable to air and moisture. Waxed string may be prepared by putting a ball of No. 18 knitting cotton into a kettle of melted grafting wax. In five minutes it will be thoroughly saturated, after which it will remain in condition for use indefinitely.

Budding.—There are numerous styles of budding, but here the one in most common use will be described. Budding is one of the most economical forms of artificial reproduction, and each year witnesses its more general use. Some nurserymen have gone so far as to use it as a substitute for all modes of grafting, save whip grafting in the propagation of the dwarf pear. Budding is economical in the amount of wood used from which to take buds. In this method a single bud does the work of the three or more upon the scion used in grafting. But while it is economical of wood, it is expensive in the use of stocks, a seedling being required for each tree, while, with the piece-root system of grafting, two, three, or more stocks can be made from a single seedling.

The operation of budding is simple and can be done with great speed by expert budders. The expense of the operation is, therefore, not more than that of whip grafting, although the work has usually to be done in July, August, or early September. The usual plan is for a man to set the buds and a boy to follow closely and do the tying.

The Bud.—The bud should be taken from wood of the present season's growth. Since the work of budding is done during the season of active growth, the bud sticks are prepared so that the petiole or stem of each leaf is left attached to serve as a handle to aid in pushing the bud home when inserting it beneath the bark of the stock. This is what is usually called a shield bud and is cut so that a small portion of the woody tissue of the branch is removed with the bud.

The Stock.—The stock for budding should be at least as thick as the ordinary lead pencil. With the apple and pear a second season's growth will be necessary to develop this size, while with the peach a single season will suffice; hence peach stocks can be budded the same season the pits are planted. Consequently the peach is left until as late in the season as is practicable in order to obtain stocks of suitable size.

The Operation.—The height at which buds are inserted varies with the operator. In general, the nearer the ground the better. The cut for the reception of the bud is made in the shape of a letter T. Usually the crosscut is not quite at right angles with the body of the tree, and the stem to the T starts at the crosscut and extends toward the root for an inch or more. The flaps of bark caused by the intersection of the two cuts are slightly loosened with the ivory heel of the budding knife, and the bud, grasped by the leaf stem as a handle, is placed under the flaps and firmly pushed in place until its cut surface is entirely in contact with the peeled body of the stock. A ligature is then tightly drawn about, above and below the bud, to hold it in place until a union shall be formed. Bands of raffia about 8 or 10 inches long make a most convenient tying material. As soon as the buds have united with the stock the ligature should be cut in order to prevent girdling the stock. This done, the operation is complete until the following spring, when all the trees in which the buds have "taken" should have the top cut off just above the bud.

Budding and Grafting Compared.—The removal of the top forces the entire strength of the root into the bud, and since the root itself has not been disturbed by transplanting a more vigorous growth usually results from the bud than from scions in whip or crown grafting. The one objection to budding is that it causes an unsightly crook in the body of the tree unless the tree is planted deeply enough in the orchard to cover the deformity. In rigorous climates, where trees upon tender roots are likely to suffer from severe winters, a bud of a hardy sort upon a tender root is no hardier than the root, because budding leaves a portion of the stock exposed above the surface of the soil and thus precludes the possibility of the development of roots from the portion above the bud; while a piece-root-grafted tree with a long scion is practically the same as a tree propagated from a cutting, as the scion will strike root and the new plant will be upon its own root. In regions where severe winters do not enter as a factor there is undoubtedly a number of reasons why budding will be the most desirable method of reproducing horticultural varieties.—(F. B. 157.)

Regrafting Bearing Trees.—Regrafting is sometimes very desirable when it is found, after trees have come into bearing, that their fruit is worthless. When the trees are not too old and are in a healthy condition the change can be made with good results. But when the trees have attained a considerable age, and have lost their vitality to a considerable extent, it would be a waste of time and expense to attempt to change them. Better plant new trees. If, however, in the case of healthy, vigorous trees, it is considered advisable for graft tops, it is not best to do this all at one time. Only about one-third of the tree should be grafted in the first year, selecting branches in the center and top of the tree. The next year another third may be grafted, and the remainder the following year.—(F. B. 113.)

Root Grafting.—Thrifty 1-year-old stocks grown from seed are taken up in the fall and stored in a cellar or buried in the soil, where they will keep fresh and be accesible at any time in winter. The scions having been secured in the fall, the work of grafting may be performed at any time during the winter. The roots only are used in this method, and they may be cut in two or more sections, according to their size and length or the desire of the propagator. But the larger or stronger roots as a rule may be relied upon for the most satisfactory results.—(F. B. 113.)

TOP WORKING ORCHARD TREES.

The top working of orchard trees is concerned with the insertion of buds or scions in the tops of the trees after they are established in the orchard. It may be practiced upon trees of bearing age which it is desirable to transform into better sorts; or it may refer also to trees recently planted which may be top-worked for other purposes. The fruit grower may have planted varieties that are not adapted to his climatic conditions, or when the orchard reaches bearing age, may find that the varieties are not true to name, and are inferior or even worthless. In many of the orchards that were planted about twenty-five years or more ago, especially in the Southern States, the trees are of varieties that were brought from sections having entirely different climatic conditions, and as they are not adapted to the South, the orchards have been unprofitable. Under any of the conditions mentioned, it may be possible to convert the orchard into a paying investment by top working the trees with buds or scions of better kinds, and it is this form of top working that is most widely known and practiced. Top working may be useful also in building up broken down tops of highly prized trees. It may be employed in grafting varieties into the tops of self-sterile trees to insure cross pollination. It may be practiced in re-forming the tops of trees like the peach, and it is especially useful in testing new varieties by bringing them into early bearing by top working them into bearing trees.

There are many varieties of orchard fruits desirable for commercial orchards or for domestic use that are lacking in hardiness or vigor. The trees may be susceptible to sunscald or to insect troubles, and are short-lived and unproductive when propagated in the usual manner. With a view to correcting these difficulties, orchards are sometimes planted with a single hardy, vigorous, straight-growing, long-lived variety. A year later, or as soon as the trees are well established and growing strongly, selected buds of the permanent varieties are grafted or budded in the body or branches, and the original tops are removed as soon as the new buds start into growth. This method of establishing an orchard by double working is growing in favor, especially with apple growers who wish to provide some desirable quality through the stock not found in the body of the permanent variety, or to grow an orchard from buds taken from trees of superior merit.

To Modify Vigor.—There is a nice balance between the roots, the stem or body, and the top of the tree, and each part has a strong influence on the vigor of the other two. The slow-growing quince root, the doucin and paradise apple, and the mahaleb cherry and sand cherry reduce the normal vigor of the pears, the apples, the cherries, and the plums worked upon them, and make dwarfing or semidwarfing possible. The Northern Spy, Ben Davis, and Fallawater apples, all strong-growing varieties, develop an unusually vigorous root system in the stocks on which they are worked. In a similar way a strong-growing body invigorates both the top and root systems of the tree. The Jonathan, Wealthy, Oldenburg, Esopus, and Red Canada apples are thrifty but of slender growth, and all of them partake of the vigor of Northern Spy when top-worked on it.

In a similar manner the slender-growing cherries are made stronger when worked on the vigorous mazzard stocks. Pears are invigorated when worked on stronger growing bodies, and it is a common practice in some nurseries to double-work slender-growing varieties like Bosc, Winter Nelis, Barry, Wilder, and Danas Hovey on strong-growing bodies like Kieffer or Bartlett. Slender-growing plums, like Lincoln, are greatly strengthened when top-worked on the vigorous Marianna, and the Japanese chestnut is invigorated when worked on the American species.

Top working therefore becomes an important factor in making slender and weak-growing but otherwise desirable varieties of greater value. A striking example of the influence of a strong stock on a less vigorous variety is found in the Red Canada apple, which, under the name Steele's Red Winter, was extensively worked on seedling stocks in Wayne County, Mich., in the early history of apple growing there, sixty-five or seventy years ago. Under these conditions the variety was vigorous, prolific, a long keeper, and popular in the markets of the West. It was therefore propagated widely in the nurseries, but, when grown upon its own body, the trees were slow and weak in growth. For this reason the variety when grown from nursery-propagated trees, was generally condemned, and was commercially obscured for many years. But in the orchards in which the variety happened to be grafted on Northern Spy, or Tolman, it still retained the old-time vigor and productiveness of the early orchards that were top-worked on strong-growing seedlings. At the present time the variety is regaining its former prestige in Michigan, where its commercial value depends on top working it on a strong-growing variety.

Methods of Obtaining a Self-Rooted Tree.—There are several practical ways of establishing a fruit tree on its own roots. Kieffer pears, Marianna plums, and most myrobolan plum seedlings, as well as some of the Japan plums, like Satsuma, may be grown from cuttings. With apples, scions may be whip-grafted on a piece of seedling root, and the scion planted at least 6 inches deep in strong, rather moist, but well-drained soil. In dry soils and dry seasons, the scions do not strike roots, but under favorable conditions the scion throws out a root system the first year. The original piece root may be removed, if it has thrown out roots, when the tree is taken from the nursery. Plums and pears may also be self-rooted by whip-grafting scions on piece roots.

In California the Northern Spy has been successfully self-rooted by inserting the scion by a veneer graft in the side of a whole seedling root a few inches above the crown. The root and scion are planted with the scion at least 6 inches in the ground. At the end of the season, after the scion has thrown out roots, the trees are lifted and the seedling root removed. The trees are then reset in the nursery, where they are cultivated until large enough for orchard planting.

One of the most successful methods has been followed in Iowa. It consists in inserting a scion of the desired variety on a piece or whole root. The trees are grown in the nursery for two years, then taken up and laid in trenches. Each branch, after being slightly cut on the upper side, is bent up and well covered with earth, after the usual method of layering. The branches strike roots during the first season at the cut and bent portion, and in the fall or following spring they are removed from the parent tree and planted in the nursery, where they are cultivated until large enough for the orchard.

To Hasten Fruitfulness.—The insertion of buds in bearing trees hastens the fruitfulness of the variety. As Sorauer says, "by this insertion of a younger portion of a plant on an older stock the former can reap all the advantages of the more advanced age of the latter; it becomes, indeed, older itself." Apples and pears bear in two to five years earlier on scions in bearing trees than they do on nursery-propagated trees of the same varieties, and peaches, plums, and cherries one to three years sooner.

To Perpetuate Desirable Characteristics.—Fruit trees are generally propagated in nurseries from buds taken from vigorous nursery stock. Occasionally the propagator selects the buds from bearing trees, though the stand of nursery stock is smaller and the trees less vigorous. The nurseryman is primarily concerned in producing a block of vigorous, well-grown trees at the cheapest cost. The fruit grower, in the past, has not concerned himself with the individuality of the stock from which the nursery trees are propagated. His highest ideal is a big, well-grown tree, straight in body, well branched, and well rooted. The two ideals have, therefore, been harmonious.

But progressive fruit growers, and some nurserymen, are beginning to pay attention to the character of the parentage of nursery stock. The Baldwins and Elbertas in the same orchards differ in size, productiveness, color, form, keeping quality, and relative immunity from disease. In fact, no two trees of a variety are exactly alike, and among the individuals or buds of which the treetop is composed there is also more or less variation. Sometimes the fruit or foliage on a branch is so unlike the rest of the tree that a new variety is introduced by propagating from it. These strongly marked variations are known as "sports," and the Pierce grape, the Banks apple, and the Delaware (*Cannon's Early*) peach are sport varieties that appeared on branches of the Isabella, Gravenstein, and Mountain Rose, respectively.

It has been assumed that the smaller variations of a variety, such as more productive individual trees, larger or more highly colored fruit, or more vigorous foliage, are likewise transmissible. There is little doubt that permanent variations in a tree, no matter how small, may be transmitted by budding or grafting, but a practical difficulty lies in determining whether a variation is inherent or incidental to the food supply or other surroundings of the tree or branch. A well-fed, properly pruned, and carefully tilled and sprayed tree has larger foliage, is more vigorous, and produces better fruit than a neglected tree. But there is no reason to expect a transmission of these superior qualities in full degree, unless the descendants are surrounded with an equally favorable environment.

The stability of a variation can be determined only by comparing it for several years with other trees growing under similar conditions. If the tree or any of its branches persists in producing fruit or foliage of particular merit, or if the bearing habit is more regular, it is highly desirable to propagate the variety from such trees or branches. There have been no accurate or long-continued experiments in propagating fruits from trees of superior merit. The effort, however, to propagate only from the best is based upon sound principles of plant improvement, and is to be strongly encouraged.

Top working may therefore be used by the fruit grower to perpetuate desirable staple variations. The variety may be budded or grafted on a desirable stock after the trees are established in the orchard. Similar results may be brought about by the nurserymen by propagating only from specially selected buds, but the cost of growing the trees will be greater, and they will need to be sold at a higher price.

Bearing Age of Young Top-Worked Trees.—Scions inserted on old trees bear at an early age, but it is uncertain whether the fruiting of scions grafted on a young tree is accelerated. Young trees, however, top-worked with buds from bearing trees, will bear a year or two earlier than trees propagated with buds from nursery stock, but it is uncertain how much of the influence is due to the top working or to the precocity inherited from the already productive parent. Peach trees propagated from buds from bearing trees develop fruit buds the first year while in the nursery.

Details of Top Working Young Trees.—A single variety selected in accordance with the principles mentioned in the preceding paragraphs is desirable for a stock on which to top work the young orchard. Every consideration of permanency and uniformity discourages the use of miscellaneous seedling stocks. Every seedling is a distinct variety, and no two are alike in hardiness, vigor, immunity from climatic or other difficulties, or in longevity. In severe climates the stock should be established on vigorous, hardy roots; but in other localities the greatest uniformity may be expected from well-grown self-rooted trees, or from trees propagated on specially selected vigorous seedling roots. Where a check to the growth is not especially sought, the stock should at least equal in vigor the variety worked upon it, or the scion will eventually overgrow the stock.

In planting, the stock should conform to the usual age for setting the fruit. The tops may be budded with the permanent variety later in the same season if the trees are growing vigorously, or they may be grafted or budded during the second season. It is advisable to top work the orchard as early as possible after it is well established, as the shock to the tree by removing the original top and the loss in energy expended in the growth of the top increases with its age.

The young orchard may either be grafted or budded, or grafting and budding may be used in combination on the same tree. The trees may be worked on the body or branches, or on both in combination. Grafting is the process of inserting a scion on a stock so that the growing parts of both are in contact. The operation is performed in the spring just as the foliage is pushing forth, though it may be done either a little earlier or later. There are many kinds of grafting, but with young trees in which the branches are not over three-eighths of an inch in diameter, the tongue or whip graft is most common. In making it the scion and stock are cut diagonally, after which a vertical cut is made in the cut surface of each. The tongue of the scion and the cleft in the stock are then joined together and the parts are held firmly with a bandage of waxed string or cloth. The cleft graft is used for larger branches. In branch grafting the scions are inserted in three to five branches well distributed over the trunk, in accordance with the grower's ideal for a top.

The branch-grafted tree develops into a shapely form if the scions live, but the death of one or more of the scions destroys the balance of the top. This may be corrected by inserting a June bud on the same branch or by budding it in the fall, or by regrafting it the following spring. It is a difficult matter, however, to restore the proportions of a top where the scions are of different ages. In some sections the larvæ of bud moths play havoc with the scions just as they are starting into growth, and make the establishment of a well-formed orchard a most difficult undertaking. The trouble may be largely overcome by inserting the buds in the body of the tree instead of the branches, when any one of the buds alone may become a leader and form a top. A single scion is sometimes inserted in the body of the tree, and although it is often successful the method is objectionable, as the stock alone remains if the scion perishes.

Budding.—Budding is the insertion of a bud attached to a piece of bark upon the growing part of the stock. There are many kinds of budding, but the shield bud is usually employed with the more common fruits. The operation may be performed whenever the bark will slip, which occurs just as growth is starting, again in early summer, and in late summer and early fall. In the North budding is usually done from the last of July until the first or middle of September, with mature buds of the season's growth. The buds remain dormant until the next spring. In the South, June budding is also practiced with immature buds, which start into growth the same season. Budding is sometimes done in early spring with dormant buds taken in the winter and retarded in a cool place.

In top working young trees the budding may be done in the branches, on the body, or in both in combination. The branches are selected in the same manner as outlined for grafting, though a bud may be inserted in the body of the tree if no branch is suitably located. The buds should be inserted on the branches several inches from the body of the tree, so that the same branch may be rebudded or grafted if the original bud perishes. With spring budding, a second bud may be inserted in June if the first bud dies, and a bud may be inserted in the fall if a June bud dies. A graft may be set or a bud inserted in the spring on a branch in which a fall bud dies.

One of the most satisfactory methods of budding young trees is to insert the buds in the body. An ideal top can be formed, as the buds can usually be placed in the most desirable positions on the body. A striking advantage also lies in the capacity of any single bud to form a leader and make a top in case of the death of the remaining buds.

Budding is usually more satisfactory than grafting. The operation is more simple, the wound heals more quickly, and the form of the tree can be regulated to better advantage by inserting the buds on the body, but the most satisfactory results follow the adoption of both branch and body budding on the same tree when one is needed to supplement the other.

Care of the Top-Worked Young Orchard.—The spring grafted or the spring or fall budded tree should have the remaining branches removed as soon as the scions or buds start into growth. The branch should be cut off an inch or two beyond the bud, and a month or two later, when the danger to the new shoot from blowing out is lessened, it should be cut close to the shoot, so that the end of the branch may heal over during the season. It is not always advisable to remove the entire top from a June-budded tree as soon as growth starts, as the buds may grow too vigorously and be blown out. If the water shoots that arise on the body and branches are left until the next spring, the growth of the buds will be retarded.

The top-worked tree needs the most careful attention during the first season. Except in June-budded trees, the water sprouts should be removed three or four times to prevent dwarfing or smothering the scions. During the latter part of July or early in August the rank-growing branches may be headed in to stock them up, and the side branches may need pruning to strengthen them and to give the top a desirable form. After the first year, the tops are treated like any other tree of the same age.

Top-Working Bearing Apple Trees.—There are many apple orchards not over 25 to 30 years of age in good, healthy condition that might be top-worked with better varieties. It is not profitable to top work larger trees, as the large branches that need removing do not heal over readily, and the tree usually dies from decay. It is also too expensive to set the scions in the large trees. An apple tree may be remodeled in three or four years by inserting scions in part of the branches each successive season. Branches larger than 2½ inches in diameter should not be grafted, as they do not heal over, and are also more susceptible to sun scald. The operator should endeavor to maintain the original form of the tree. The branches at the top are cut off rather close to the body, and at a greater distance as the base is approached. The large branches need shading while the remodeling is in process. This may be provided by distributing the scions evenly throughout the tree each year and by leaving some of the older branches. Only a few branches should be grafted in one place in a single year, as the exposed stubs, especially in the Southern States, are usually scalded. It is always advisable to graft a larger number of branches than necessary for the final top. The scions shade the branches and may be removed as they overcrowd.

A top-worked tree requires close attention if the operation, which is harsh at the best, is to be successful. All large wounds should be painted with red lead to prevent the entrance of fungi and bacteria. The scions should be watched to prevent their dwarfing and smothering by overhanging branches. Water sprouts, which appear in abundance, need removing in June. Every endeavor should be used to re-cover the tree as quickly as possible, and to protect it from injury while the operation is in progress.

The grafting is done in the spring with dormant scions, two of which are inserted in a horizontal position in each stub. The stub and the end of each scion are then carefully waxed.

Top Working Bearing Peach Trees.—There has been a large development in the peach growing business in the last decade. With the rapid growth of the industry many varieties have been planted in large quantities that are undesirable for commercial purposes or ill-adapted to the regions in which they are located. There are also many orchards more than 10 years old, with trees still vigorous, but of varieties that are no longer equal to the newer commercial sorts. To sacrifice the orchards by cutting them out means a loss of labor and capital already invested, but to leave the trees unchanged continues an unproductive investment. It is possible to top-bud these orchards with better varieties, and it may be desirable from the commercial standpoint to do so if the trees have been given good care, as new tops may be formed that will produce good crops in three or four years.

The budding may be done either in June or in the fall, the season depending on the locality and the convenience of the grower. The buds may be inserted on the main branches if the diameter of the latter within 6 or 8 inches of the trunk is not over 1½ inches. On larger trees it is not advisable to bud the main branches, but new shoots in which the buds can be inserted may be provided near the trunk of the tree by cutting off the main branches within 1½ to 2 feet of the body, and by thoroughly cultivating the soil after the heads are removed.

In preparing the tree for fall budding it is often possible to pick the fruit, then cut back the top, and insert the buds in three to five of the main branches near the trunk, the distribution of the buds having regard for the form of the future top. In large trees the cutting back is done the preceding winter or spring to provide the new shoots for budding. In the South, however, where fruit is harvested earlier in the season, it is possible to take the crop, remove the top, and then by frequent cultivation provide new shoots on the larger branches that can be budded in August of the same year.

As soon as the new buds start into growth the old top should be entirely removed and the branches bearing the buds cut back close to the bud. The new shoots that grow on the old branches should be kept off, and the new head formed in accordance with the grower's ideal for a top. It may be advisable to head in the shoots of the new top during the first summer to stock them up and prevent long, slender, weak branches. The ends of the old branches should be painted with red lead to prevent the entrance of fungi and bacteria which cause their decay. If care is exercised in all of the operations, the new top may bear profitable crops for many years.—(Y. B. 1902.)

ORIGIN AND CLASSES OF THE CULTIVATED APPLE.*

(*a*) The true apples have descended from the *Pyrus Malus* of Europe. Characteristics: Woolly twigs, calyx, and flower stems; fruit various, but always holding its calyx. The common apple of commerce comes from this species. (*b*) The crab apples have descended from the *Pyrus baccata* of Europe. Characteristics: Growth smooth and more wiry than that of the true apple; leaves narrower, thinner, and with longer stems than *Pyrus malus;* flower clusters and leaves seldom woolly; fruit small on long, wiry, slender stems; seed inclosed in hard, close-fitting hulls; calyx falls off when fruit is mature. Very few of these are cultivated. The Yellow and Red Siberian are, perhaps, of this parentage. (*c*) Hybrid crabs are known to botanists as *Pyrus prunifolia.* They are undoubtedly the result of crosses between the true crabs and the larger apples. In this group are included most of the so-called crabs of commerce, such as the Transcendent, Hyslop, Sweet Russet, and Excelsior. (*d*) *Pyrus coronaria* is the American crab apple. The largest or Western form has become known as *Pyrus ioensis.* This is a native of the Mississippi Valley eastward. Characteristics: Tree vigorous, young growth woolly; leaves often deeply indented; fruit green or later yellowish; aromatic, hard, bitter, keeps through the winter; resembles quince in quality, and is used, like the quince, for flavoring apple sauce and jellies. There are a few of these varieties in cultivation and among them are the Soulard and the Fluke. It does not readily cross with the cultivated apple.

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* For illustrations, see pages 33, 51, 105, 141, 213, 411.

Among cultivated varieties of apples we often find several that closely resemble each other in fruit, foliage, and habit. Some of these groups are as follows: (*a*) The Fameuse group includes: Fameuse, Shiawassee Beauty, and McIntosh. (*b*) The Duchess of Oldenburg group includes: Duchess, Borovinka, Gilbert, and Charlamoff. (*c*) The Ben Davis group includes: Ben Davis, Gano, Shockley, and Black Ben Davis.—(U. S. E. S. B. 178.)

Lists of Varieties Suited to Large Areas.—As many of the desirable varieties are extremely local in their range of adaptability, it will not be possible to present a selected list that will be suited to all sections of the country. It is the aim in making up the following lists to include only varieties of known merit and to divide the country into districts, or large areas, in which the conditions of soil, climate, latitude, elevation, etc., are more or less adapted to the sorts named in the several lists. From these lists the planter may select such as are suitable for his own locality, bearing in mind the fact that there are others within his reach that may be profitably added to those here named. In the choice of varieties the planter should be governed largely by the results and experiences of those who have preceded him in his immediate vicinity. Two or three trees of each of the earlier ripening varieties will afford sufficient fruit for any ordinary-sized family. Should the farmer desire to plant, in addition to his family orchard, varieties suitable for commercial purposes, such are designated in these lists by an asterisk; thus, *Baldwin. The arrangement of the following lists is approximately in the order of ripening:

FOR THE NEW ENGLAND STATES, NEW YORK, PENNSYLVANIA, NEW JERSEY, NORTHERN OHIO AND INDIANA, AND MICHIGAN.

For this district the following varieties are suggested:

Tetofski.
*Yellow Transparent.
Early Harvest.
*Red Astrachan.
Red June.
*Oldenburg, *Duchess of.*
Golden Sweet.
Trenton Early.
Redtsripe.
Early Strawberry.
Early Joe.
Benoni.
Primate.
Maiden Blush.
Gravenstein.
Fall Wine.
Jefferis.
Jersey Sweet.
Rambo.
Porter.
Mother.
Melon.
Fall Pippin.
Bailey *Sweet.*
Jacobs Sweet.
Fameuse.
Shiawassee *Beauty.*
Wealthy.
*Grimes *Golden.*
*Jonathan.
Romanstem.
Westfield.
Red Canada.
Smokehouse.
Delicious.
Hubbardston *Nonsuch.*
*Tompkins King.
Domine.
Wine.
*Northern Spy.
Sutton.
Wagener.
Esopus *Spitzenburg.*
*Rome Beauty.
Roxbury *Russet.*
*Baldwin.
*Ben Davis.
*Rhode Island Greening.
*Stark.
*Winesap.
*York Imperial.
Lansingburg.
*Yellow Newtown.[a]

FOR DELAWARE, MARYLAND, VIRGINIA, WEST VIRGINIA, SOUTHERN OHIO, SOUTHERN INDIANA, KENTUCKY, TENNESSEE, AND NORTH CAROLINA.

For this district the following varieties are suggested:

Yellow Transparent.
Early Harvest.
Red June.
Trenton Early.
Golden Sweet.
Early Joe.
Early Strawberry.
Benoni.
Primate.
Redstripe.
Jefferis.
Horse.
Fall Wine.
Porter.
St. Lawrence.
Gravenstein.
Melon.
Fall Pippin.
Wealthy.
Shiawassee *Beauty.*
Jacobs Sweet.
Rambo.
*Grimes *Golden.*
*Jonathan.
*Northern Spy.
Esopus *Spitzenburg.*
Bonum.
Blue Pearmain.
*Ben Davis.
Buckingham.
McAfee.
Delicious.
Fallawater.
*White Pippin.
Arkansas *Mammoth Black Twig.*
Carter Blue.
Rome Beauty.
Yates.
Stark.
*York Imperial.
Akin.
Ralls *Genet.*
*Stayman Winesap.
*Winesap.
Shockley.
*Yellow Newtown.

FOR SOUTH CAROLINA, NORTHERN FLORIDA, GEORGIA, ALABAMA, MISSISSIPPI, LOUISIANA, AND TEXAS.

For this district the following varieties are suggested:

*Yellow Transparent.
*Red Astrachan.
Early Harvest.
Red June.
Yellow June.
Summer Queen.
*Oldenburg, *Duchess of.*
Horse.
Summer Pearmain.
Taunton.
Fall Pippin.
Bonum.
Watson.
Shockley.
*Ben Davis.
Kinnard.
*Hoover.
*Winesap.
Yates.
Terry.

FOR NORTHERN ILLINOIS, WISCONSIN, MINNESOTA, IOWA, AND NEBRASKA.

For this district the following varieties are suggested:

Tetofski.
*Yellow Transparent.
*Red Astrachan.
Early Harvest.
Red June.
*Oldenburg, *Duchess of.*
Golden Sweet.
Early Joe.
Redstripe.
Hightop Sweet.
Primate.
Benoni.
Cole Quince.
Jefferis.
*Maiden Blush.
Charlamoff.
Borovinka.
Longfield.
Porter.
Gravenstein.
St. Lawrence.
Alexander.
Wolf River.
Dyer.
Fall Wine.
Ramsdell.
Lowell.
Fall Pippin.
*Wealthy.
Mother.
Rambo.
Fameuse.
*Shiawassee *Beauty.*
Peter.
Melon.
Delicious.
McIntosh *Red.*
Lady Sweet.
*Grimes *Golden.*
Westfield.
Newtown Spitzenburg.
Esopus *Spitzenburg.*
Domine.
Romanstem.
*White Pippin.
Rome Beauty.
McMahon.
*Stark.
Patten *Greening.*
*Willow.
*Jonathan.
*Hubbardston *Nonsuch.*
Wagener.
Red Canada.
Minkler.
Tolman *Sweet.*
English Russet.
Ralls *Genet.*
Northwestern Greening.
*Winesap.
*York Imperial.
Lansingburg.

FOR SOUTHERN ILLINOIS, MISSOURI, KANSAS, ARKANSAS, OKLAHOMA, AND INDIAN TERRITORY.

For this district the following varieties are suggested:

*Yellow Transparent.
*Red Astrachan.
Early Harvest.
Red June.
Trenton Early.
Kirkbridge.
Early Strawberry.
*Oldenburg, *Duchess of.*
Summer Rose.
*Maiden Blush.
Benoni.
Summer Pearmain.
Jefferis.
Porter.
Fall Wine.
Wealthy.
Melon.
Rambo.
Buckingham.
Bailey *Sweet.*
Fulton.
*Grimes *Golden.*
*Jonathan.
*Missouri *Pippin.*
*Ben Davis.
*Gano.
Ohio Pippin (*Shannon*).
*Stark.
*Rome Beauty.
*White Pippin.
Huntsman.
Collins (*Champion*).
Oliver (*Senator*).
*Arkansas, *Mammoth Black Twig.*
*Akin.
Clayton.
Paragon.
Golden Russet.
*Stayman Winesap.
Gilpin.
*Winesap.
McAfee.
*York Imperial.
Ralls *Genet.*
*Ingram.
Delicious.

FOR NORTH AND SOUTH DAKOTA AND THE COLDER PARTS OF WYOMING AND MONTANA.

For this district the following varieties are suggested:

Tetofski.
*Yellow Transparent.
*Oldenburg, *Duchess of.*
Longfield.
St. Lawrence.
*Wealthy.
Hibernal.
Wolf River.
Cherlamoff.
Antonovka.
Utter.
Gideon.
Peter.
Pewaukee.
English Russett.
Plumb Cider.
Borovinka.
Okabena.
*Fameuse.
*Patten *Greening.*
Northwestern Greening.

FOR COLORADO, UTAH, NEVADA, AND NEW MEXICO.

For this district the following varieties are suggested:

Tetofski.
*Yellow Transparent.
Early Harvest.
*Red Astrachan.
Red June.
*Oldenburg, *Duchess of.*
*Maiden Blush.
Porter.
Gravenstein.
Wealthy.
Wolf River.
Bailey *Sweet.*
Alexander.
*Grimes *Golden.*
*Jonathan.
*Ben Davis.
*Gano.
Missouri *Pippin.*
*Northern Spy.
Fallawater.
Tolman *Sweet.*
Delicious.
*Tompkins King.
Esopus *Spitzenburg.*
Hubbardston *Nonsuch.*
Red Canada.
*White Pearmain.
Yellow Bellflower.
Domine.
Golden Russet.
*Roxbury *Russet.*
Pecks *Pleasant.*
*Rome Beauty.
Wagener.
Akin.
Limbertwig.
Ralls *Genet.*
Swaar.
*Winesap.
*Ingram.
*Yellow Newtown.
*Arkansas.

FOR IDAHO, OREGON, WASHINGTON, AND THE WARMER PARTS OF WYOMING AND MONTANA.

For this district the following varieties are suggested:

Tetofski.
*Yellow Transparent.
Early Harvest.
*Red Astrachan.
Red June.
*Oldenburg, *Duchess of.*
*Maiden Blush.
Gravenstein.
*Wealthy.
Wolf River.
Fall Pippin.
Fameuse.
*Grimes *Golden.*
*Jonathan.
Tolman *Sweet.*
*Rome Beauty.
Red Canada.
Missouri *Pippin.*
Westfield.
Golden Russet.
*White Pearmain.
*Winesap.
Yellow Bellflower.
*White Pippin.
Hubbardston *Nonsuch.*
*Baldwin.
Ralls *Genet.*
*Tompkins King.
Wagener.
Roxbury *Russet.*
*Esopus *Spitzenburg.*
*Ingram.
*Yellow Newtown.
Delicious.

FOR CALIFORNIA AND ARIZONA.

For this district the following varieties are suggested:

Early Harvest.
Yellow Transparent.
Red Astrachan.
Red June.
Early Strawberry.
Oldenburg, *Duchess of.*
Summer Pearmain.
Maiden Blush.
Gravenstein.
Porter.
Fall Pippin.
*Wealthy.
Alexander.
Wolf River.
Rambo.
Fameuse.
*Grimes *Golden.*
*Jonathan.
Newtown Spitzenburg.
*Tompkins King.
Esopus *Spitzenburg.*
Tolman *Sweet.*
Yellow Bellflower.
Red Canada.
Rhode Island Greening.
Swaar.
Wagener.
*Missouri *Pippin.*
*White Pearmain.
Hoover.
Hubbardston ***Nonsuch.***
*White Pippin.
Blue Pearmain.
*Stark.
*Northern Spy.
*Rome Beauty.
Ralls *Genet.*
*Winesap.
*York Imperial.
*Yellow Newtown.

(F. B. 113.)

Apples.—Apples vary greatly in form. The parts of an apple are skin, flesh, stem, cavity, calyx, basin, core, seeds, hulls, stamens, and pistils. Apples are propagated (*a*) by root grafting in cellar in winter on whole or piece roots; (*b*) by crown grafting in the field in spring, and (*c*) by budding. (*a*) Seedlings of vigorous, hardy sorts are commonly used in the best apple districts and little attention is paid to the source of the seed. In the Central Western States, where the winters are severe and the snowfall often scanty, much attention is paid to getting hardy stocks. For this purpose seedlings of the hardiest kinds are sought. (*b*) Seedlings of hardy hybrid crabs also are now much favored for severe locations and have given good results. (*c*) Seedlings of the pure *Pyrus baccata* are of great hardiness and have come into use for severe locations, especially for the Dakotas. Some varieties do not work well on it and all kinds do best on it when budded or grafted at the crown. (*d*) Dwarf apples are formed by working them on the Paradise stock, which is a dwarf apple stock much used in Europe for this purpose, but seldom used in America. It makes small trees that are adapted to training in various forms. (*e*) Top working or grafting the tops of trees is practiced in some sections to change the bearing of the trees and to overcome weaknesses in the trunk of certain kinds, as the Wealthy, which, in Minnesota, is liable to canker in the crotches. Some sorts are much more productive when top worked than when merely root grafted.—(U. S. E. S. B. 178.)

Should Apples Be Thinned?—Fair conclusions from tests are about as follows: The operation of thinning apples will cost less than 50 cents a tree and may to a slight degree reduce the expense of harvesting the fruit. It will, if crops are heavy, add from 10 to 15 per cent to the intrinsic value of the fruit by increasing the size, by improving the quality and by brightening the colors. It will probably decrease the total amount of salable apples, this decrease coming principally in the amount of second grade fruit. It will not, on mature, well-established trees, materially influence the regularity of production or the amount of fruit setting for subsequent crops. The profit, if there be any, must come from the crop thinned. It will, if judiciously applied, protect young trees from weakness through over-bearing; and will lessen the loss from broken branches and splitting of mature trees. Whether or not it will be a paying operation will depend on market possibilities. Where near a market that will respond with extra prices for extra quality, the grower of apples could probably thin with good financial results, either directly or by establishing a reputation for fine fruit. The whole question as it relates to commercial orchards is well summed up by the New York State Fruit Growers' Association: "When there is a general crop of apples and the crop is very full, so that the chance for small fruit is very great and widespread over the country, it would pay to thin to such an extent as to insure good-sized fruit. Aside from this it would not pay, only for the protection of the tree."—(N. Y. E. S. B. 239.)

Uses of the Apple.—No fruit in the North Temperate Zone can take the place of the apple as a food product. Many other fruits, indeed most cultivated fruits, rank as luxuries, but the apple in most parts of the United States is one of the leading staple products of the farm.

In its numerous varieties its seasons of maturity extend throughout the year. No other fruit of the Temperate Zone may thus be had in continuous succession without resorting to artificial means of preservation. It is preeminently useful in the household economy. As a culinary fruit none excels it. It graces the table in a greater variety of forms than any other, and as a dessert fruit few are its equal and none its superior. Its juice when extracted makes an excellent and wholesome beverage, and for vinegar it has no rival. As a market fruit it is one of the easiest and least expensive to handle, and usually finds a ready sale if well grown and handled with care.

Among the many ways in which the apple is now used the manufacture of jellies and preserves is one of growing importance. The numerous factories for the manufacture of these goods which have sprung up all over the apple-growing region of the country have not only created a demand for second and third grade apples, but also for the waste products—cores and skins—resulting from drying and evaporating the fruit. It has been found that jellies made from this apple waste are almost as good as those manufactured from whole fruit. These waste products have not only a value for the uses above mentioned, but there is a growing demand for them for export purposes for the manufacture of cheap wines and cider.

Chops for which there is also ready sale for export purposes, are made from the lower-grade apples by chopping the whole fruit into coarse pieces and evaporating them. Apple butter of the real, rich, old-time farm product, not the thin, factory-made excuse, fills an important place in the household economy and always finds a ready sale at good prices.

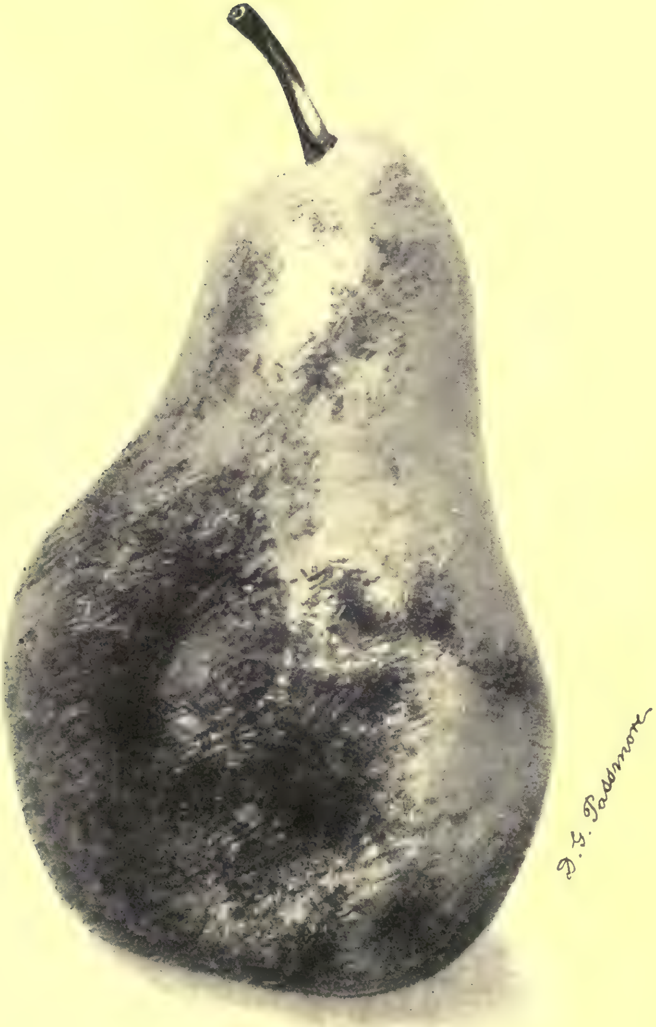
Good sweet cider made from sound apples, not from half-decayed, wormy fruit, is one of the most healthful products of the orchard, and all surplus over and above what is needed for home consumption is always in demand at remunerative prices. It can be kept sweet and unfermented by heating it to a temperature of 160 degrees F., and holding it there for thirty minutes; then sealing it up tight in bottles or casks, and storing it in a cool place. Boiled cider made in the good old-fashioned way by reducing to one-fifth by boiling, and then canned, makes an excellent article for culinary purposes, for making apple butter, apple sauce, or for use in apple or mince pies. It also has a commercial value.

While the aim of the farmer should be to supply an abundance of fruit for his own family, he should also be able to offer to the outside world a liberal surplus. The apple orchard will often bring him better returns for his outlay than any other portion of his farm, acre for acre. The product of a single tree will sometimes sell for $10 or more, and fifty such trees can be grown on an acre of land. Though we may not always count on such large results, we may safely expect the orchard to do its full duty one year with another, especially if we first do our duty by it.—(F. B. 113.)

Making Cider Vinegar at Home.—The making of cider vinegar is a familiar operation in almost every farm home. The final product is a necessity on every table, the small apples from which it is usually made are of practically no value for other purposes, the labor and expense of picking them up and pressing them are slight, and from the time the cider is in the barrel Nature does the work. Thus the process appears a simple one, easy to start, and self-operated to its termination in a salable commodity; so that the work-burdened farmer, with several barrels of cider in his cellar, may, in his few moments of leisure, think with pleasure of this farm operation which will bring him profit without further outlay of strength or money.

Yet vinegar is a food product and, as such, has come under the eye of the law, which says that to be legally salable the finished goods must meet certain requirements. Cider vinegar must contain a certain per cent of acetic acid and also of cider vinegar solids before it can be lawfully sold as pure cider vinegar, and frequently farmers who have made vinegar from pure apple juice only, and who have stored this under what they believe to be proper conditions for the proper length of time, find that their product falls short in one requirement or the other. Thus, without fraudulent intent or attempt at adulteration or dilution, the home-made vinegar falls under suspicion.

Among the conditions which may produce vinegar below standard are these: (1) The juice may be poor to start with because made from varieties of apples low in sugar, from green apples or from overripe or decayed apples; or the juice may be watered either directly or by watering the pomace and pressing a second time. (2) The fermentation processes may be delayed or disturbed by using dirty fruit or unclean barrels, thus affording entrance to undesirable organisms and causing the wrong kind of fermentation; the temperature may be too low to insure the necessary activity of favorable organisms; or air may be excluded by filling the barrels too full or putting the bung in too tight so that the bacteria can not live and work. (3) The acetic acid may disappear after its formation, destructive fer-



Crocker Pear

mentation being encouraged by leaving the bung-hole of the barrel open or the barrel only partially full. Briefly summarized, the method to be employed for the manufacture of good vinegar at home, without the use of generators, is this: Use sound, ripe apples, picked or picked up before they have become dirty, if possible, otherwise washed. Observe the ordinary precautions to secure cleanliness in grinding and pressing, and discard all juice from second pressings. If possible, let the juice stand in some large receptacle for a few days to settle, then draw off the clear portion into well-cleaned barrels which have been treated with steam or boiling water, filling them only two-thirds or three-fourths full. Leave the bung out, but put in a loose plug of cotton to decrease evaporation and to prevent the entrance of dirt. If these barrels are stored in ordinary cellars, where the temperature does not go below 50° or 45° F., the alcoholic fermentation will be complete in about six months; but by having the storage room at a temperature of 65° or 70° the time can be considerably shortened, and the addition of Fleischmann's compressed yeast or its equivalent at the rate of one cake to five gallons of juice may reduce the time to three months or less. Use a little water to thoroughly disintegrate the yeast cake before adding it to the juice. The temperature should not go above 70° for any length of time, to avoid loss of the alcohol by evaporation.

After the sugar has all disappeared from the juice, that is, when the cider has entirely ceased "working" as revealed by the absence of gas bubbles, draw off the clear portion of the cider, rinse out the barrel, replace the liquid and add two to four quarts of good vinegar containing some "mother," and place at a temperature of 65° to 75° F. The acetic fermentation may be complete in three months or may take 18 months according to the conditions under which it is carried on; or if stored in cool cellars may take two years or more. If the alcoholic fermentation be carried on in the cool cellar and the barrel be then taken to a warmer place, as outdoors during the summer, the time of vinegar formation may be reduced from that given above to 15 or 18 months. Where the alcoholic fermention is hastened by warm temperature storage and the use of yeast and the acetic fermention favored by warmth and are good vinegar "start," it is possible to produce good merchantable vinegar in casks in 6 to 12 months.

When the acetic fermentation has gone far enough to produce 4.5 to 5 per cent of acetic acid, the barrels should be made as full as possible and tightly corked in order to prevent destructive changes and consequent deterioration of the vinegar.—(N. Y. E. S. B. 258.)

EVAPORATION OF APPLES.

The utilization of the poorer grades of fruit is frequently an important matter to the grower. That portion of a crop which is of too low grade to market in the ordinary way can often be made to pay a large part, at least, of the expense of maintaining the orchard or fruit plantation if it is converted into some other form or handled in some way other than that practiced with the better grades. In some of the apple-growing districts the evaporating industry has kept pace with the planting of orchards and has become an important factor in the utilization of the fruit which is unfit or would prove unprofitable for marketing in the fresh state. In some of the older apple-growing sections, such as western New York, the number of evaporators in use is very large, and for many years, the industry has been well established. Its present state of development, however, has been a matter of gradual evolution. During its course methods have changed more or less, appliances have been perfected, and marked improvement in the construction of the evaporators themselves has been accomplished.

Many evaporators are located in villages, at railroad stations, and at other central points; a considerable number, however, are erected in close proximity to or in conjunction with apple orchards, being owned and operated by the fruit growers themselves, each plant being intended only for "working up" the fruit not otherwise marketed from a single orchard. The evaporators located in towns or villages are usually operated by men who make a business of evaporating fruit, and the apples handled in them are bought wherever they can be obtained to best advantage. These are generally of much larger capacity than the ones at the orchards, and the type of construction and the character and number of conveniences correspond.

The average weight of ripe winter apples of mixed varieties is about 50 pounds to the bushel. In evaporating them about 40 pounds of water per bushel, or approximately 5 gallons, passes off in the form of vapor. The evaporating of apples may be said, in brief, to consist of driving off as rapidly as possible, by means of artificial heat, enough of their moisture to prevent deterioration through decay or other natural processes which occur in fresh fruit and at the same time to maintain a desirable texture and flavor.

Buildings formerly used for other purposes are frequently converted into evaporators. An old dwelling house, a blacksmith shop, a cheese factory, and a schoolhouse are examples. Others are built substantially of brick or stone, thus reducing the risk from fire, which is an important consideration.

A large quantity of fruit, in the aggregate, is still dried by primitive methods. In rural communities, especially where the "home orchard" represents the extent of fruit growing, one often sees during the autumn a flat-topped rock, the roof of some low, easily accessible shed, or other flat surface on which have been spread apples, sliced or quartered, for drying in the sun. In some sections "strings" of quartered apples hanging by a doorway to dry, or behind a kitchen stove, are still familiar sights.

While much of this sun-dried fruit is intended for home use, large quantities of it are marketed, and it is also exported to some extent. This fruit is commonly referred to as "dried apples," in distinction from that handled in evaporators, which is known as "evaporated apples."

Types of Evaporators.—Many types of evaporators are now in use, though in a general classification they may be grouped, for convenience, under a few heads. The more important of these to the farmer are: (1) Cook-stove evaporators; (2) portable outdoor evaporators; (3) kiln evaporators. The descriptions which follow are representative of types only and the details of construction and arrangement admit of endless modification. For the most satisfactory results, however, in all types, thorough ventilation is essential to insure a good circulation of heated currents of air.

Cook-Stove Evaporators.—Some of the cook-stove evaporators are small box-like structures, usually made of sheet iron or galvanized iron, of such a size that they can be placed on top of an ordinary cook-stove. They are arranged for holding a series of small trays, on which the fruit is placed after it has been prepared for drying. Various sizes are in use, from one covering only a portion of the top of a common kitchen stove and having a capacity of only a bushel or so a day, to those requiring the entire top of a stove on which to operate it.

Another style consists of a water-tight rectangular box of tin, upon the upper surface of which the fruit is spread. The heat is supplied by boiling water, with which the evaporator is filled, the temperature being maintained by placing one end of the evaporator on top of a stove. There are various other styles of this type.

Portable Outdoor Evaporators.—Portable evaporators are especially convenient when it is desired to dry only a few bushels of fruit at any one time. The usual sizes have a capacity of 5 to 10 bushels a day, and even more in some cases, although the quantity will of course vary with the attention given to them. As they are complete in themselves and are not too heavy to be readily moved, they may be placed wherever convenience from time to time dictates.

There are several other styles of this type, obtainable from manufacturers which are made of sheet iron, usually galvanized. As no wood enters into their construction, danger from fire is eliminated. One of these styles is provided with a heat deflector and so constructed that hot currents of air pass over the fruit as well as up through it, the claim being made that this movement of air induces a more rapid drying of the fruit than in ordinary methods of construction.

Kiln Evaporators.—Of the types having sufficient capacity for handling apples from commercial orchards, the kiln evaporator is by far the most important. While the principles of construction of the different evaporators of this type are similar in all cases, the details and the arrangement of the appliances are endlessly varied.

An evaporator, simple in design and construction and suited for practical purposes is described in a recent publication of the Missouri Station as follows: All that is required is a plain frame building made of boxing well battened; a slatted upper floor, about 6 feet above the ground for the fruit, and a stove on the lower floor. Almost any old, plain building may easily be converted into an evaporator, and cheap, rough sheds may be built for the fruit and paring machines. This is all that is needed except the bleacher. The building should be about 24 by 24 feet, and 12 feet to the eaves, and will require no bottom floor. It should be made of good, dry, 1 by 12 inch boxing, 12 feet long, and securely battened. The floor joists should be placed about 6 feet above the ground, and be 2 by 6 inches and 12 feet long, resting upon a support in the center of the building. (A building 12 by 12 feet, or 16 by 16 feet, would be large enough for most farmers or fruit men.)

The upper floor should be made of slats 1 inch square and beveled to prevent the fruit from clogging. These are nailed to the joists, ⅜ to ½ inch apart, to allow the hot air to pass up through the fruit which is spread on this floor. The whole space on this floor should be used for drying. Entrance to the room is by stairs on the outside. One or two ventilators in the ridge of the roof will be necessary to carry off the moist hot air. Two large stoves with large drums and plenty of pipe on the ground floor will answer for the furnace, and if the drying room is but 12 by 12 feet or 16 by 16 feet, one stove will be sufficient. The stoves should be so arranged that they may be fired from the outside. Fruit bins and paring tables are arranged in a lean-to shed against the main building.

The bins for the apples are always made so as to be filled from the outside, and the fruit removed from the inside through the sliding doors. This fruit is carried in baskets or boxes and placed upon the tables where the paring is done, and as fast as pared, should be placed in boxes to be put upon the slicing machine. After slicing they are dropped into trays made 3 by 3 feet of galvanized wire and at once put into the bleaching house where the fumes of sulphur soon bleach the bruised and discolored parts to a pure white. Care must be exercised not to leave the fruit in the bleacher too long or the flavor will be seriously affected. When properly bleached, none of the fruit flavor or quality is lost, which is always the case when bleaching is done after evaporation. The bleacher can be made to hold two sets of trays, end to end, and an opening made so that they can be taken out at each end, but it is much preferable to have an iron hook so as to draw them all out at the point nearest to the stairway leading to the drying room. As soon as bleached the trays of fruit should be carried immediately to the drying room and emptied on the floor. Only a few minutes are needed for the bleaching, so that the trays can be kept in use all of the time by the slicing machine.

This prepared fruit must be put in as rapidly as possible on one side of the drying room so that it will all come out at once when ready for packing into boxes, otherwise a loss of heat and space will result. The same packing tables and the same help that do the paring of the apples may be used for packing the evaporated fruit. The boxes are lined with white paper and then two layers of the best rings are selected and put in the top of the box (the bottom when packing), and then the rest filled in carefully, rejecting anything too soft or too hard to make good fruit. The box is packed tightly and is ready for market. When the evaporator is not in use for the fruit itself it can be used to evaporate the skins and cores, which will often sell for enough to pay the expense of evaporating the apples. Care will have to be exercised if this is done to wash everything clean before using again for the fruit. Hence it is always best to keep a part of the dry room separated from the rest for this purpose alone and use it for nothing else.

APPLES SUITABLE FOR EVAPORATION.

There is an increasing demand for dried apples of the highest quality. The tendency has sometimes been to make quantity at the expense of quality. But prices are governed not only by the supply but also by the grade. The cleanest, whitest fruit, that is well cored, trimmed, bleached, ringed, and dried, is most in demand. Carelessness in any particular injures the product.

Primarily the economic usefulness of an apple evaporator is through its utilization of windfalls and the poorer grades of fruit which can not be marketed to good advantage in a fresh state, and it is these grades that are most often evaporated. But the magnitude of the crop also influences the grade of the evaporated product in a decided way. In seasons of abundant crops and low prices for fresh fruit large quantities of apples that would ordinarily be barreled are evaporated and the grade of stock produced is correspondingly improved. On the other hand, in years of scanty crops, when all apples that can possibly be shipped are in demand at high prices, only the very poorest fruit is evaporated, as a rule, thus lowering the grade of the output.

The commercial grading of evaporated apples is based primarily on appearance rather than on dessert quality, and the fact that one variety may make a better flavored product than another is not considered. As a rule, a product of high commercial grade can be made from any sort which has a firm texture and bleaches to a satisfactory degree of whiteness. A variety of high dessert quality, such as the Northern Spy, may be expected to make an evaporated product of correspondingly high flavor.

In sections where the Baldwin apple is grown extensively it is in demand at the commercial evaporators, as it meets the requirements in a fair degree and is also available in relatively large quantities. In the Ben Davis sections that variety supplies a similar demand.

Most early varieties lack sufficient firmness of texture for the best results and are undesirable on this account. On the other hand, some comparatively early sorts, such as Gravenstein and Yellow Summer Pearmain, are considerably prized in some sections; the dessert quality of the latter is especially high.

Similarly the product made from other sorts possesses qualities that are due more or less to varietal characteristics. For instance, that from Esopus is said to be unusually white; Hubbardston and varieties of the Russet group also make very white stock. The latter make relatively a large amount of stock, by weight, to a given quantity of fresh fruit. Limbertwig is said to produce from 1½ to 2 pounds a bushel more of dried stock than most sorts do, but it is not as white as that from some other varieties.

Time Required for Drying.—The time necessary for drying fruit depends upon several factors. The more important are: Type of evaporator; depth to which fruit is spread; method of preparing—whether sliced, quartered, or whole; temperature maintained; conditions of the weather, and, to a certain extent, the construction of the evaporator.

The application of these several factors to the point in question readily follows. A good kiln evaporator should dry a floor of slices, other things being equal, in about twelve hours, ten to fourteen hours being the range of variation. Where the fruit is handled on racks the time required is much shorter, but conditions are quite different from the kilns, as the fruit is seldom more than 1 or 2 inches thick on the racks. For slices, five hours is considered a reasonable time, with a range of four to six hours. It is estimated that the quarters will require from eighteen to twenty-four hours in the average kiln, while the time for whole apples will range from thirty-six to forty-eight hours.

If the atmospheric conditions are heavy and damp, the drying is retarded. Under some conditions it is hardly possible to thoroughly dry the fruit. During windy weather also it is more difficult to regulate the heat, especially if the walls are poorly constructed so that the draft of cold air into the furnace room can not be controlled. This applies especially to kilns heated by furnaces. It is claimed that steam-heated evaporators are less subject to the influence of climatic conditions.

When Is the Fruit Dry?—Perhaps there is no step in the entire process that requires better-trained judgment than the matter of determining when the fruit is sufficiently dried to meet the requirements. Like several other steps in the process it is largely a matter of experience, though there are certain general features which are capable of being reduced to words.

The fruit should be so dry that when a handful of slices is pressed together firmly into a ball the slices will be "springy" enough to separate at once upon being released from the hand. In this condition there will be no fruit, or only an occasional piece, that has any visible moisture on the surface. In a slice of average dryness, it should not be possible to press any free juice into view in a freshly made cross section of it. The general "feel" of the fruit, as it is handled, should be a soft, velvety, leathery texture.

Temperature Maintained.—The temperature maintained in kilns or other drying compartments, in actual practice is largely a matter of experience, not a factor governed by any definite standards or regulated in accordance with thermometer readings, as might be expected. In general, the object in view is to force the heat as high as possible without endangering the fruit. A probable temperature which has been suggested by some of the operators is 150° F., or more when the fruit is first put into the drying compartment, dropping to about 125° F. as the drying process nears completion. Sufficient and proper provision for controlling the indraft of cold air below the fruit will aid in maintaining the desired temperature.

Weight of Evaporated Apples.—Some varieties of apples will make more evaporated stock to the bushel than others. The grade used also effects the amount, but an average weight—a frequent basis of estimates—is about 6½ pounds of white fruit and 3½ pounds of waste to a bushel of fresh fruit. When the apples are dried whole, without slicing, they will make from 1 to 2 pounds more to the bushel than when sliced.

Storing the Fruit.—In years of great abundance of apples, the evaporated product is likely to exceed the immediate demand. While fruit that has been well bleached and cured can be held for a considerable period of time without loss it is by no means imperishable. The color is first to deteriorate. The fruit appears to lose the effect of bleaching after a time and turns dark. Though it may retain its flavor for a long time, its unattractive appearance renders it more or less unsalable.

When it is desired to hold evaporated apples from one season to another, recourse is had to cold storage. Some seasons large quantities are handled in this way. The temperature at which it is stored is usually from 32° to 35° F., or about the same as for fresh fruit. If well bleached and properly cured it may be held for a relatively long period. Four or five years is said by commercial handlers to be about the usual limit of time before the color deteriorates. It is seldom, however, that it is desirable to hold the fruit for so long a time.—(F. B. 202; F. B. 291.)

THE CRAB-APPLE.

This group of apples is often very much neglected by the fruit-grower and farmer. They are often regarded as a wild, rugged and worthless form of the apple, bearing only thorns and insipid astringent fruit. Acquaintance with the rather common native crab (*Pyrus angustifolia*) and its astringent fruit is largely responsible for this notion. It is true that very few of the apples classed as crabs have any value at all for dessert purposes, yet this group fills an important place in the list of culinary fruits, and some of the varieties are excellent eating out of hand. No other apple fruit is superior to the best crab-apples for making preserves, jellies and marmalades, while the superiority of some varieties over the common apple for making cider is recognized. It is more than likely that this type of apple, because of its astringent qualities, is yet to play a very important part in the manufacture of high class ciders. Moreover, if the fruit of the crab-apple was absolutely worthless for dessert and culinary use, it would still deserve some attention at the hands of the farmer, for as an ornamental tree it furnishes a profusion of bloom and fragrance during its blooming period equal to many ornamental plants, and they are mostly hardy. From this standpoint alone, it deserves the best of care and attention in every family orchard. A few of the best varieties planted in the family fruit garden may be made to serve the purpose of an ornamental plant and at the same time furnish in abundance a very useful fruit.

The origin of this group of apples and its relation to the common apple are subjects of great interest to the horticultural student, because of the part they may possibly yet play in the origination of hardy new varieties of commercial apples, but a brief statement of the botanical relationships of the crabs will suffice our purpose here. The Siberian or true crab-apple belongs to the species *Pyrus bacatta,* which is a native of Asia. The larger and more improved varieties of cultivated crabs are thought to be hybrids of these true crabs and our common apple (*Pyrus malus*) of Europe. They are generally referred to *Pyrus prunifolia,* a name used by botanists to designate this race of hybrid apples. Our native American crabs have yielded several cultivated varieties, thus adding to the list apples of a type altogether distinct from the older well known varieties of crab-apples. A number of the small apples of the common apple type (*P. malus*) are often erroneously spoken of as crabs. In fact, the term crab-apple is often applied to any small apple not adapted for dessert use. In the notes below, we make no attempt to classify the different varieties, but adopt the simple method of treating them in alphabetical order.

Culture of the Crab.—The best culture methods for this group of fruit is not unlike that required by our common varieties of apple. They are not as vigorous in growth, and will therefore need less pruning, and may be planted much closer together than the common apple; 20 to 25 feet apart each way is a good distance for the trees. Those varieties which belong to the Siberian group, such as Red Siberian and Lake Yellow are upright in habit, and are slower growers than those of the hybrid type, and therefore may be planted even closer than above directed.—(Va. E. S. B. 132.)

A Few of the Better Varieties of Crab-Apples.—Blushing Maid—Heavy and sure bearer of good quality. Hyslop (America)—Beautiful red Crab of fair quality; productive; late. Lake Yellow—Above medium size, productive, rich and fine quality; excellent variety. Maiden Blush—Fairly good variety; rather large size; fair quality, but light bearer. Montreal Beauty (America)—Good bearer, handsome and of fair quality, though not rich. Quaker Beauty—Good quality; only fairly productive. Queen—Very heavy bearer; showy fruit, of fair quality; medium size; late. Red Siberian (France)—Well known early variety; one of the best in quality; very productive. Soulard (Missouri)—Sure bearer; fairly productive; fruit harsh, astringent. Transcendant (America)—Early variety of best quality; good bearer and showy fruit. Whitney (Illinois)—Early variety; fine quality; free from astringency and excellent for eating out of hand.—(Va. E. S. B. 128.)

APPLES ON THE SMALL FARM.

Gathering the Crop.—After the family has been supplied with all the apples needed from the family orchard, there is generally a demand in our markets for all surplus from the time of the earliest ripening throughout the year, and for this reason the farmer should know how to handle this surplus to the best advantage. The proper stage of maturity at which it is best to take the fruit from the tree, if for sale, will be governed somewhat by the distance to the market to be supplied. If near by, and requiring no shipping, the fruit may be left on the tree until nearly mellow, which is the best condition for summer and fall varieties for dessert purposes. But if to be shipped a long distance it should be picked as soon as the seeds are fully matured. Winter sorts may be allowed to remain on the tree as late in the fall as will be safe against freezing, but if the fruits of any varieties should commence to drop from the tree they should be gathered at once.

No specific date for gathering can be given, because of variation in climate with latitude. The orchardist must determine the proper time, judging from the condition of the fruit. Fruit for any season of the year should be carefully picked and the stem not broken, avoiding bruising or breaking the skin. No strain should be made on the stem at its juncture with the apple, as is likely to occur by jerking it from the tree, for decay is apt to set in at its base. Grasping an apple with the hand, placing the thumb at the tip of its stem for a fulcrum, and suddenly giving it a turn over the thumb will separate it from the branch without injury.

At the time of gathering summer and autumn ripening sorts, they should be assorted and packed into the regular apple crate or box as fast as picked, protected from sun and wind, and sent to market each day. All blemished and undersized fruit should be rejected, as it does not pay to mix in the crate any apples which have been damaged by insects or careless handling. No matter how large and fine-appearing an apple may be, cast it aside if blemished.

Winter sorts require the same care in picking and assorting. They may be piled up in the orchard under the trees for a while without danger of injury and assorted and packed in barrels after the gathering is done, but it will be a saving of expense and much better for the fruit to place it at once in open crates or boxes and haul it to a storage room, where it may be put into bins, each variety by itself.

In packing it is the common practice to face the lower end of the barrel with two layers of selected apples. This is what is termed "facing," for it is this end that is opened when examined by the buyers. The balance of the barrel is then filled up loosely until about half full, when it is gently but thoroughly shaken down; then the filling is completed, rounding up the barrel more than full, the head is put on and pressed into position by means of lever or screw, and hoops are put on and nailed fast. If the apples are properly shaken down while filling the barrel the final pressing and clamping should not injure or mar the last layer of fruit. The safety of the packing consists in firmly compressing the fruit so as to avoid any rattling about, otherwise it will not stand handling without injury. In some sections of the country boxes are used instead of barrels, but the same care is necessary to fill the box full so as to prevent the fruit from rattling about.

Disposition of the Crop.—As heretofore stated, the crop of summer and autumn apples requires an immediate disposition, either by sale in the market, or by evaporation, or by manufacturing into cider. If properly picked, assorted, and packed, they will "stand up" for several days, and in the lack of a near-by market may be shipped quite a distance safely. But unless the farmer has a convenient near-by market there will be little profit in growing early perishable varieties. The crop of winter varieties can be handled more profitably, as it is not so perishable.

The stock of early winter sorts may be held in safe storage for a while if a paying market can not be found at once, but generally it is best to sell before freezing weather comes on, or as soon as packed, and while the apples are in prime condition. There is no certainty of any gain in holding for any length of time for an advanced market price on any of the winter class of apples unless the grower has in his own right good facilities for storage; and even then the stock will require reassorting to fit it for market, when often a loss in stock greater than the gain in advanced price will occur through rot or shrinkage. There is, however, and especially when markets are glutted, a chance to gain in market prices by holding the stock of the late-keeping varieties for a while until the glut is relieved; but whenever a paying market is available, even at small margins of profit, it is the best business economy for the producer to dispose of his crop at once and thus avoid the risk of losses owing to decay and shrinkage which are liable to occur by holding; also the probable additional expense of reassorting. There may be seasons, of course, when a known shortage in the general crop will justify holding for advanced prices, but such a condition is exceptional, not general.—(F. B. 113.)

SUMMER APPLES.

Growing the Fruit.—In general, it may be said that the orchard management requisite for the production of this class of fruit does not differ materially from the usual methods employed in growing winter apples. The same pruning, cultivating, fertilizing, spraying, etc., are required in the one case as in the other. The later sprayings commonly recommended for late varieties are not so necessary for the earlier sorts for obvious reasons, though the early applications should be made with the same thoroughness that is required for winter sorts. It is a question worthy of consideration, however, whether later applications made after the fruit has been harvested would not be worth while, at least in the case of varieties especially susceptible to fungous diseases, in order to protect the foliage during the long period between harvesting and the end of the season. The vigor and healthfulness of the trees might thus be insured and the crop the following season perhaps improved thereby.

Handling the Fruit.—The methods employed in handling early apples are much more closely allied to those used in marketing peaches than to the usual manner of caring for winter varieties. This results naturally from the character of the fruit. As a rule the fruit is intended for immediate consumption and is not usually marketed until fully ripe, or, at least, in suitable condition to use without delay. As its period of duration is short when edible maturity is reached, it must of necessity be used within a comparatively few days after it is put on the market. Some varieties, however, intended only for cooking, are shipped as soon as they are large enough for this purpose, without much regard to the degree of maturity which they may have reached. Although such varieties may be held longer than those marketed in a thoroughly ripened condition, they soon begin to deteriorate if held for any considerable length of time.

Harvesting.—In harvesting early apples careful hand picking is practiced by a majority of the most successful growers. A few firm-fleshed varieties, the fruit of which ripens irregularly and drops as soon as it is well colored and fully ripe, are sometimes allowed to drop their fruit. If there is danger of the apples being bruised by striking the ground, a heavy mulch of straw is spread beneath the trees. But many of the most particular growers prefer to hand pick even these sorts, though it is rather laborious to do so on account of the ripe fruits being much scattered over the trees.

Some of the less exacting growers shake the fruit from the trees or beat it off with poles, claiming that the difference in price between the carefully handled fruit and the fruit handled by their method is not enough to justify the extra expense of hand picking. It should be noted, however, in this connection, that careless or rough handling of fruit in harvesting often accompanies indifferent methods of culture. The grade of the fruit grown frequently determines the expense that is justifiable in preparing it for market.

The period of growth from blossoming to maturity is relatively short, and the changes which occur in the development of the fruit take place with corresponding rapidity. It may be only a very short time, as measured by days, between a date when an apple is too immature to pick and the period when it becomes overripe. Because of this, several pickings of most varieties are usually made, as in picking peaches.

Grading and Packing.—In the marketing of early apples the details of grading and packing require the same painstaking attention that the successful marketing of other quickly perishable fruits demand. Fruit that is bruised should be discarded. Though it may not appear to be defective when it is packed, bruises and other similar blemishes, especially in case of certain varieties, become very conspicuous after the fruit has been picked a short time. Even if it looks well when packed, such fruit is likely to deteriorate greatly before it reaches the market.

Some of the early apples are prepared for market in the orchards, but most of them are taken to packing houses, where they can be more conveniently handled.

Packages.—Several different styles of packages are used for early apples, of which the following are the most important. In some sections the ⅞-bushel crate, formerly much used for shipping peaches, was commonly used in the earlier years and is still seen occasionally, though it has passed out of general use.

The growers in the New Jersey section who market their fruit in Philadelphia use the half-bushel peach basket, usually without covers. In other important sections a ⅞-bushel basket with cover has been used for several years with excellent satisfaction.

A few growers pack their fancy fruit in six-basket carriers and find that for some markets it pays to incur the additional expense which this style of package makes necessary. Twenty-pound Climax baskets are also used occasionally.

Methods of Selling the Fruit.—Several methods of selling early apples are practiced. Perhaps the most simple one is that employed by the growers who are located within 15 to 20 miles of Philadelphia. The fruit is packed in half-bushel baskets as above mentioned, loaded on large wagons built for the purpose and hauled directly to the commission houses or other markets. In some cases the grower runs his own stand in the market, perhaps handling truck and other farm produce at the same time. By either of these methods the packages are returned to the grower.

At the more important shipping centers the growers sell f. o. b. as much as possible, thus avoiding all risk in transit and the possibility of loss from poor market conditions. This method makes it possible to ship in car lots, as the buyer fills his cars ordinarily with fruit purchased of different growers.

Markets and the Place Held by Summer Apples.—Very naturally, large and relatively near-by distributing centers receive large quantities of summer apples. To a less extent, some of the more distant markets receive more or less fruit especially of certain varieties. During the past few years, however, with better transportation and storage facilities, new and more distant markets have been sought.

Foreign markets offer an outlet for considerable quantities of early apples, especially when the European crop is light. The results of the experimental export shipments made by the Bureau of Plant Industry indicate that for fruit of good grade properly handled and when the markets are not overstocked with home-grown fruit, good returns may be expected from London, Liverpool, and some of the other leading foreign markets.

As an important commercial product, summer apples are a comparatively new commodity in many markets and their use has been limited. They have not filled a place comparable with that held by peaches, winter apples, and some other fruits. Hence, in the past the period of real demand for them has usually been during a scarcity of other fruits. There is evidence, however, that a very large number of consumers have now come to think of summer apples as filling a definite place in their food supply. While the demand is naturally more or less influenced by the abundance of other fruit in the markets during the summer-apple season, it is not so much dependent upon the availability of other fruit as in the earlier years and it is becoming more constant as the regularity and abundance of the supply of early apples increases.

The Problem of Varieties.—There are several fundamental features which should always be considered in selecting the varieties of any kind of fruit to be grown in a given region or under particular conditions. The purpose for which it is to be grown, whether dessert or cooking, home consumption or market, should be given due weight. A variety may behave in a certain manner, ripen its fruit during a particular period, and show other habitual characteristics when growing under a certain combination of conditions of soil, climate, elevation, and cultural methods. When the variety is grown under other combinations of conditions it may behave in a very different manner. In other words, a variety is subject to the influence of the conditions under which it is grown. In those conditions there may be involved both natural factors, such as soil and climate, and factors which are more or less artificial, such as are imposed by man in his methods of culture.

Discussion of Important Varieties.—The following varietal list includes the most important early varieties which are grown in the middle Atlantic coast region, and a considerable number of others. The dates given in the columns headed "Season begins about" refer to the approximate periods when the different sorts are fit for use or can be marketed, and not necessarily to the date of full maturity. Where the 15th of a month is stated, it should be broadly interpreted to mean the middle of the month; likewise the 25th refers to the last of a month rather than to an exact date. A similar interpretation should be given to other dates mentioned.

Use, Relative Importance, and Season of Edible Maturity of Summer-Apple Varieties Suited to Growing in the Middle Atlantic States.

Variety.	Use.	New Jersey section		Chespeake peninsula section.		Virginia section		North Carolina section	
		Relative importance	Season begins about—	Relative importance	Season begins about—	Relative importance	Season begins about—	Relative importunce	Season begins about—
Alexander	km	3	July 25						
Bachelor Blush	km	3	Aug, 25						
Benoni	d	3	Aug. 20			3	July 10		
Bonum	d					3	Sept, 1	1	Aug. 25
Bough	d	2	July 10	2	July 10				
Celestia	dkm			3	Sept. 5	3	Sept. 1		
Champlain	km	2	July 25	2	July 25				
Colton	km			2	July 10				
Cornell	d	3	Aug. 15						
Early Edward	d	3	July 25	3	July 25				
Early Harvest	dk	2	July 5	2	July 5	1	June 25	1	June 15
Early Joe	d	3	July 25	3	July 25				
Early Ripe	km			1	July 1			3	June 15
Early Strawberry	d	2	July 15	2	July 15				
English Codlin	km	2	July 25						
Fanny	k	3	....do....	3	July 25				
Golden Sweet	dk			3	....do....			3	July 15
Gravenstein	dkm	1	Aug. 5	1	Aug. 5	1	July 25		
Horse	k							1	July 15
Jefferis	d			3	Aug. 1	3	July 25		
Jersey Sweet	d			3	Aug. 15	3	Aug. 10		
July	km			1	July 10				
Keswick	km	3	July 25						
Lowell	dk	3	Aug. 1						
Maiden Blush	km	1	Aug. 15	1	Aug. 10	1	Aug. 1		
Metz	k							2	July 25
Oldenburg	km	2	July 20	2	July 20	3	July 15		
Orange Pippin	km	3	July 25						
Primate	d	3	July 15						
Randolph	km			2	July 20				
Red Astrachan	km	1	July 10	1	July 5	1	July 1	1	June 25
Red June	dm			2	July 10	1	....do....	1	June 15
Roadstown	km	2	Aug. 1						
Smokehouse	dkm	3	Sept. 10			1	Sept. 1		
Starr	km	1	July 15						
Summer Hagloe	km	1	July 20	1	July 20				
Summer Rose	d	3	July 15	2	July 10				
Tetofski	km	3	....do....	3	July 15				
Wealthy	dkm	2	Aug. 1						
Williams	dkm	1	July 20	1	July 20			3	July 1
Yellow Transparent	dkm	1	July 5	1	July 1	1	June 20	1	June 10

d (*dessert*) suitable for eating uncooked, k (*kitchen*) suitable for cooking. m (*market*) suitable for market.

In the table several varieties are rated as of first importance in either the New Jersey or the Chesapeake peninsula section, but are not mentioned as being grown at all in either of the other sections. The conditions in each section are sufficiently similar to suggest the probability that a variety which can be grown with a high degree of success in any one of them is at least a promising sort for trial in others.—(B. P. I. B. 194.)

COMMERCIAL APPLE ORCHARDING.

Handling and Disposition of Apple Crops.—The financial success of a commercial apple orchard depends largely upon the methods used in picking, sorting, packing, and disposing of the crops. These operations involve a large share of the expense of the enterprise; hence the owner should carefully study and investigate the most recent and economical methods in practice by others before he adopts any. If the crops are rightly handled there will be no difficulty in finding a ready market for choice first-class winter apples.

All fruit must be carefully hand picked, avoiding bruising or breaking of the skin or straining of the stem at its juncture with the apple, for a loosening of the stem at its base will induce rot to set in as quickly as the breaking of the skin. Some orchardists use for a picking receptacle a convenient-sized basket, lined or padded to avoid bruising, with an adjustable bail, so as to allow the fruit to be carefully dumped in piles under the shade of trees. To the piles barrels are hauled and distributed for packing, and a gang of sorters and packers follow, sorting and packing the fruit into the barrels. Another method is to use a 2-bushel grain sack which has its ends so fastened together with a strap or cord that it can be swung under the left arm, the strap crossing the right shoulder, and the open end of the sack, with a hoop in it to keep it open, resting on the breast, thus enabling the picker to use both hands.

A platform wagon filled with open-headed barrels follow the pickers between rows, and the fruit is emptied from the sacks into the barrels until filled, when the load is drawn to a packing house (constructed on the premises) provided with long sorting tables, where it is dumped. The fruit is sorted and packed direct from the tables into the barrels.

The time for picking the apple must be determined by its maturity or stage of ripeness, and not by any particular date. Some varieties should be picked much earlier than others, for upon the stage of maturity and time of picking depend largely the keeping quality of the apple. Sometimes a difference of one or two weeks in date of picking will show marked difference in keeping. If the apple is left on the trees after it is fully matured the ripening process will go on more rapidly than if taken off and placed in a cool room or cellar or taken at once to cold storage. It is better to be on the safe side and pick the fruit a little before maturity rather than to leave it until overripe. The common practice of allowing the fruit to remain in heaps under the trees for several days is a mistake. The sooner the apple is removed after picking to the cool cellar or to cool storage the better will it keep.

Careful and systematic sorting is an important matter in handling fruit. No imperfect, unsound, or blemished fruit should be allowed in the first-class No. 1 grade. The grading should be uniform. Any small specimens, as well as oversized ones, detract from the appearance of the whole lot in the package. The standard size should be an average of the variety when well grown; to be first-class it should be in regular form, free from fungous disease, and of clear color, to become attractive in the market. If the sorting and grading is honestly and faithfully done there will be no difficulty in finding a ready paying market for first-class winter apples. The requirements on grading worthy of consideration by the commercial orchardist, are quoted, as follows:

"The standard size for No. 1 apples should not be less than 2½ inches in diameter, and shall include such varieties as Ben Davis, Willow Twig, Baldwin, Rhode Island, and other varieties kindred in size. That the standard for such varieties as Romanite-Russet, Wine-sap, Jonathan, Missouri Pippin, and other varieties kindred in size shall be not less than 2¼ inches. And, further, that No. 1 apples shall be at time of packing practically free from the action of worms, defacement of surface, or breaking of skin; shall be hand picked from the tree, a bright and normal color, and shapely form.

"No. 2 apples shall be hand picked from the tree; shall not be smaller than 2¼ inches in diameter. The skin must not be broken nor the apple bruised. This grade must be faced and packed with as much care as No. 1 fruit."

Every orchard of considerable size should be provided with some sort of a storage house, either for temporary or permanent storage of apples, for without such place the orchardist is liable to loss and inconvenience. The storage house should have ventilation, and be opened by night and closed by day, so as to control the temperature in a manner to secure the right condition for preserving the fruit. It should also be constructed so as to have conveniences for sorting and packing the fruit as it is brought from the orchard. A fruit house, if properly constructed with air spaces in the walls, will serve to keep out frost, so that the grower may hold his fruit for a considerable length of time, thus giving him better opportunity for disposing of his crop.

Packages and packing are among the essential items of a well-managed orchard. The package almost wholly in use in the Eastern, Middle, and Western States is the apple barrel of standard size, 17⅛ inches in diameter of head and 28½ inches in length of stave, with bulge not less than 64 inches, outside measurement.

The box package is used entirely on the Pacific coast and in the States of the Northwest, and for several reasons this is preferable to the barrel. It is better suited for the retail trade, as small consumers can better afford to buy fruit in such a package than in a barrel. It is more convenient for handling, and occupies less space in shipping; it also carries the idea of a finer quality. Another advantage it has over the barrel is that it can be made much more attractive by use of display labels, such as are used for oranges, lemons, and other fine fruits. This kind of package will in time supersede all others for both the wholesale and retail trade. If this package is used, the fruit should be carefully graded to uniform size and packed in layers; if wrapped in paper similar to that used for oranges, it will be found to keep better and will command a higher price than the unwrapped fruit. A fancy display label bearing the name of the variety and the name and address of the grower or dealer should be put on each box. If honest work is done in grading and packing, the owner can soon gain a reputation, so that as soon as his brand is seen the purchaser knows at once what he may expect to find all through the package when it is opened. A box, holding about one-half a bushel, would be convenient for the small purchaser in the retail trade.

If the barrel package is used it should be set on end, and after removing the upper head, firmly pack at the bottom two layers of apples, which should be a fair sample of the entire contents of the barrel; arrange the layers so that the stem end of the apples will face downward. Then fill the barrel loosely until about half full; gently but thoroughly shake the fruit down, then fill the balance of the barrel, rounding it up to a little more than full; the head is then put on and pressed down into place with a screw or lever and the hoops put on and nailed fast. The ends of the barrel are reversed, and on the end having the faced layers should be marked the true name of the variety inclosed and the name of the grower or packer; this label will indicate the end to be opened.

It is quite a common practice among many extensive orchardists to sell their entire crop of apples while on the trees, the purchaser doing all the work of picking, sorting, and packing. When the proprietor possesses sufficiently good judgment to be able to closely approximate a safe valuation of the crop, and a fair price is offered, that is an economical and satisfactory way of disposing of a crop, as there is much hard, vexatious work, and more or less risk to run in gathering, packing, and handling of the crop. But in case the owner chooses to handle his crop, an immediate sale, as soon as it is barreled and ready for the market, is considered the safest and surest way to dispose of it. The holding over for a better price in future is more or less risky, and oftentimes results in loss from shrinkage and sometimes the necessity of re-sorting and packing, which would require more of an advance in the market price to make the loss good than often occurs.

All of the crop left after assorting out the No. 1 and No. 2 grades should be classed and treated as culls, and sold to evaporating and canning establishments or to cider makers, unless the owner has all the facilities at hand for working them up. For extensive orchards the profits on the by-products will justify the expenditure for buildings and machinery necessary for working them up. In some instances the by-products of the orchard have been known to exceed in value returned the receipts from the main crop. Of course, such were exceptional cases. It is also true that no permanent profit ever

PLANT OF A WILD SOY BEAN. DEPT. OF AGR.

comes to the producer who would compel his good fruit to sell his culls for him.—(Y. B. 1901.)

THE PACKING OF APPLES IN BOXES.

Boxes.—Two sizes of boxes are used in the west, the standard and the special. These differ slightly in width and height (one half of an inch) as well as in length, which adapts them to the different sizes of apples. If, therefore, an apple, because of its size, will not pack well in one size of box, it certainly will pack in the other. Most of the western growers have a supply of both sizes on hand. The dimensions of these boxes are as follows: (a) Standard, 10½x11½ x18 inches inside measurement; (b) Special, 10x11x20 inches inside measurement. Material. Ends, ¾ inch; sides ⅜ inch; tops and bottoms, two pieces each, ¼ inch thick. There should be four cleats for each box, two at the top and two at the bottom. The sides of the box should be nailed with four nails at each end of each side. The cleats should be put neatly on the box and four nails driven through them and through the top or bottom into the ends. Cement-coated or rosined nails are preferable, either six-penny or five-penny. A third size of box is offered for sale in the east. It conforms to the bill to regulate the size of barrels and boxes and the grading of fruit, a bill which has been pending before Congress for two years. The bill specifies that the box shall contain 2,342 cubic inches, and the inside dimensions of this box as sold are approximately 10½x11½ x19½ inches. A few other sizes differing from those mentioned above are sold by manufacturers in the east. Odd sizes, however, should be avoided. The boxes are delivered in the shooks and nailed up by the growers themselves. The names and addresses of manufacturers can be secured from the advertisements in the farm papers.

Lining Paper.—The box is lined on the bottom, sides, and top with a white paper called "lining paper." No lining is placed at the ends. Lining paper is made from "white news" in different sizes, according to the box: for the standard, 17¾x26 inches, and for the special, 19¾x26 inches. This paper can be purchased of any wholesale paper dealer, and should cost approximately 3½ cents per pound, or about $1.20 per thousand sheets. One piece of lining paper is put into the box in such a way as to cover a little more than one half of the bottom and all of one side, enough still being left to fold over a little beyond the center when the box is packed. Another piece is put into the box in a similar manner on the other side. And then in order to prevent the tearing of the lining paper along the sides at the bottom, when the top is nailed on and the bottom bulges, a plait or crease is made in the lining paper at this place. The plaits lie across the corners and provide plenty of slack. In the west some growers plait the lining in this manner; others do not.

Layer Paper.—The general practice in the use of the layer paper is to place one sheet on the bottom and one on the top, inside the lining paper. In some cases, however, it is necessary to use layer paper between the layers of apples to raise the pack, so as to come out right at the top. The height of the pack will guide the packer in each case. Colored manila tagboard is used for this purpose, size 17½x11 inches or 19½x10½ inches, according to the box. The approximate cost of this paper should be $7.50 per thousand sheets. It can be purchased from any wholesale dealer in paper.

Wrapping-Paper.—Most of the growers in the west wrap every apple. It takes but little more time to do this, and the wrapper adds greatly to the character of the pack. A wrapped apple packs more easily and firmly than an unwrapped apple. The wrapper acts as a cushion to prevent bruising and also checks the spread of disease from one apple to another. In addition, a box of wrapped apples conveys an impression of greater carefulness.

The wrapping-paper used in the west is a light manila, smooth on one side and rough on the other, the rough side being placed next to the apple. Often the wrapping sheets are stamped with the brand of the individual or association which handles the fruit. In New York this paper can be purchased of dealers in fruit-growers' supplies, or it can be secured at a wholesale paper store. The size of the wrapper will vary somewhat according to the size of the apple. For the medium and larger apples 10x10 inches is a good size; for the smaller apples 8x10 inches. If one is handling apples of different sizes, it is well to have both sizes of wrapping-paper on hand. The cost of this paper should be about 4½ or 5 cents per pound, or about 35 cents per thousand sheets.

To wrap an apple attractively and quickly is a matter of practice, and the knack is soon attained. The packer stands at the table so that he can pick up an apple with one hand and place it in the box with the other. The wrapping-paper is held in a hod which hangs on the side of the box. To pick up a sheet of wrapping-paper easily, the packer wears a rubber stole on the thumb or middle finger. These rubber stoles can be purchased at almost any drug-store. With the left hand the packer reaches for a sheet of paper; at the same time with the right hand he picks up an apple. The apple is thrown gently into the center of the paper, which is held in the palm of the left hand. With the right hand the packer draws in the corners of the paper, and then with a slight rolling motion completes the wrapping, and in so doing leaves the apple in the left hand in the proper position to pack in the box. The operation, however, being an individual matter, will differ somewhat with each packer. In every case the object should be to make a neat and attractive wrap and do it quickly.

Packing-Table.—A convenient packing-table can be easily built by any grower. The bed of the table is 3 x 4 feet, covered by a double layer of canvas. In order to enable the packer to shake off quickly any dirt or leaves which may gather, the top layer is fastened at one end only. Each end of the table is extended about one foot on which to rest one end of the box. As a rest for the other end a board projecting about one foot at the side is fastened to the bottom of the bed. These supports for the boxes are built at alternate corners of the table. Shelves on which to place wrapping-paper, lining paper, or layer paper are often built beneath the table.

Box-Press.—A box-press can be devised in various ways, the essential points of construction being: (a) to rest the box on the ends so that when the top is nailed down the bottom is free to bulge also; (b) to catch and press down the top pieces from the ends so that a minimum bruising will result. A convenient press is shown in diagram where the different parts are described. The box lies across the open space in the center, the pieces being caught and clamped at the end by the arms. This press is built for boxes of different lengths.

Packing.—Before placing the apples on the packing table they are usually graded into different sizes. The grading is done by men who are trained for the work. They take the fruit from the boxes as it comes to the packing-house from the orchard and grade it into different sizes. It is then placed on a table, where it is ready for the packer. For growers in the east who are beginners it may be helpful to use a sizer or "grader" at first.

WHAT VARIETIES SHALL BE BOXED.

An important question in the east in connection with this problem is: What varieties shall be packed. Possibly a consideration of the market will solve the question: Where and by whom are the apples used? A large part—probably the larger part—of the apples grown in New York, and other parts of the east, such varieties as the Rhode Island, Baldwin and Ben Davis, is used for cooking. For these varieties the barrel now used is well adapted.

At the same time, a large number of fancy varieties are grown, such as the Northern Spy, McIntosh, Esopus, Yellow Newtown, Fameuse, Jonathan, and the like, which are used for dessert. Such apples are in demand. The consumer is willing to pay a good price for a fancy article. For such varieties it would seem that the box is better adapted than the barrel. In the first place the barrel is too large, and in the second place, it does not adapt itself to careful packing, because of which there is too much bruising. The box is a better size and is well adapted to careful and attractive packing. Then, too, some of the varieties will pack well in either the box or the barrel, according to the market for which they are intended. The Baldwin might be mentioned as such a variety. Below is given a table of the common varieties, arranged as adapted to the box or the barrel.

VARIETIES SUGGESTED FOR PACKING IN BOX OR BARREL.

Box.	Either box or barrel.	Barrel.
Esopus.	Alexander.	Alexander.
Fall Pippin.	Baldwin.	Baldwin.
Fameuse.	Gilliflower.	Ben Davis.
Grimes.	Hubbardston.	Gano.
Hubbardston.	Rhode Island.	Rhode Island.
Jonathan.	Rome.	Roxbury.
McIntosh.	Tompkins King.	Twenty Ounce.
Northern Spy.	Twenty Ounce.	
Tompkins King.		
Wagener.		
Wealthy.		
Yellow Newtown.		

An erroneous impression seems to prevail in regard to boxed fruit. Some growers think that, in order to get a good grade of fruit for boxing, it is necessary to sort out the fancy apples of a variety, and thus to depreciate the value of the rest, which we pack in the barrel. Such is not the case. To be sure, boxed fruit should be first-class, but all such fruit is graded into different sizes, small, medium, and large, all of the small fruit being packed together, the medium by itself, and so on. If, then, an apple is first-grade, as first-grade fruit should be, it will fall into one of these sizes, and the smaller size is no less valuable than the larger. Whatever we pack in the box, therefore, would be first-grade fruit of the variety as it runs, sorted into different sizes, the pack and the box being adapted to the size.—(Cornell E. S. B. 298.)

COLD STORAGE OF APPLES.

In seasons with abundant crops, what is best to do with one's fruit,—sell at the market price, or arrange to hold it for future advance? This question appeals to every one who has apples for sale. To sell the fruit at picking time leaves little opportunity for competition, and results in low prices and limited responsibility. To keep the fruit for higher prices involves loss in the cost for storage buildings and the liability of shrinkage and decay; also extra expense in handling, danger from freezing in transportation, etc.

From the nature of the case, conditions vary and the problem is for the individual to settle. That cold storage of some form is profitable is readily recognized. We have had in recent years fruits of all kinds out of season and at prices within the reach of most people. The economic problem is not to secure a high price for a small quantity but an average price for a large quantity.

Not many years since we depended almost entirely upon the house cellar for tiding over a glutted market, and when there was a slump on the market much of the produce rotted in the hands of the producer. A certain few, however, even then solved the problem by proper handling, packing, ventilating their cellars, etc.; and they invariably received fair returns for so doing. New methods of storage have developed rapidly within a short time. At present every city of note has its commercial cold-storage plant and producers as well as commisison men are offered equal opportunities for rental.—(N. H. E. S. B. 93.)

Advantages of Home Cold Storage.—1. With cold storage at home fruit can be stored quickly and without the injuries caused by shipping. This is of especial importance if it is to be sold on the local market. The shipping of fruit injures it unless the most extreme care is taken. Fruit is often shipped to distant warehouses and, after the storage season, is shipped back to the same locality from which it came. This would be avoided by home cold storage. Fruit should be stored as soon as taken from the tree. This is impossible, when dealing with distant warehouses, but possible where there is home cold storage.

2. Fruit in home cold storage can have the constant personal

care of the owner. He can examine it when he wishes and sort when necessary; he can sell it by the bushel or barrel in a week or a month and pay no extra storage fee.

3. Should the commodity deteriorate in quality, or the price fail to advance, the owner is out nothing for transportation and little for storage.

Advantages of Storing Fruit in the Cities.—Fruit stored in the warehouses of the larger cities has several advantages which with commercial growers are very important.

1. It is nearer the market, where it can be disposed of on the shortest notice. This enables the holder to take advantage of a sudden turn in price for the better. By use of the telegraph he can dispose of his whole crop in a few minutes.

2. By storing in city warehouses, fruit does not usually have to be shipped after it has been in storage. Shipping after storage is an injurious process and should be avoided. But if it must be done, the facilities for loading in the large warehouses are such that the fruit need not undergo change of temperature or injury. Adjoining the storage rooms are loading sheds which are kept very cool. The refrigerator cars in which the fruit is to be shipped are run into the sheds and the fruit is taken from the storage room directly into the cars, which are already cooled to a low temperature.

3. Fruit in city warehouses is practically on exhibition all the time, and if it is of superior quality it is a standing advertisement for the owner. Buyers find out to whom to look for such fruit. Commercial reputation and standing is no small thing in these pushing times. A man must not only grow fruit of first quality, he must make it known that he grows it. He will profit by storing it where buyers can find it.—(Kas. E. S. B. 84.)

KEEPING QUALITY OF APPLES.

Like all farm and orchard operations of the present time, apple storage must receive careful attention to insure success. The grower or buyer must learn what varieties are suitable for storage, what conditions must be provided to secure the best and most economical management of the stored fruit, and at what time and under what conditions the different varieties must be put on the market. Apples are exceedingly variable in length of keeping: Early Harvest often becomes too ripe and mealy for choice eating while still upon the tree; while Schodack, in ordinary storage, may keep well until midsummer of the next year. They also vary in behavior in storage, some varieties scalding, shrinking, losing flavor and becoming dull colored and unattractive, while others, after six months keeping, come out smooth, bright, fragrant and crisp. These variations in behavior are to a great extent varietal characteristics; yet the same variety grown upon sand or upon clay, grown in the North or in the South, grown in a wet season or a dry one, may show very striking differences. The problem of selecting varieties and storing them properly is, therefore, a complex one; and requires careful study.

Conditions Affecting Keeping Quality of Apples.—The keeping quality of apples is influenced by many conditions, among which are the ripeness of the fruit, season, manner of picking, packing and handling, kind of storage, presence of fungi and temperature at which the fruit is stored. Overgrown specimens do not keep so well as those of medium size. Thick-skinned varieties generally keep better than thin-skinned ones. Keeping quality is often correlated with degree of coloring up of the fruit. To keep best, colored apples should be picked only after they are well colored but while they are still firm. This point is reached when the plump seeds are black. But in order to keep longest in *cold* storage Rhode Island Greenings must be picked while they are still very green and hard. They will then carry through without any scald until very late in the season. But Rhode Island Greenings appear to hold best in *common* storage when they have ripened well on the tree. Rhode Island Greenings are in condition for picking for longest holding in *cold* storage when the bloom on the fruit rubs off easily and leaves the skin rather shiny. This rule is said to apply less markedly to Baldwins and probably to other varieties.

Methods of harvesting, packing and handling in transportation have the greatest influence on keeping quality. Handlers of apples sometimes roll barrels of fruit, allowing them to strike against other barrels. This rough handling may bruise the fruit almost to the middle of the barrel. But some varieties are more easily injured by rough handling than are others. Northern Spy is one of the easiest to bruise and barrels are often found to spoil in storage early on this account. Tolman Sweet and Yellow Bellflower are other varieties very sensitive to rough handling.

Storage men emphasize and reiterate the point that cold storage can only be successful when fruit is handled very carefully—more carefully than fruit is now often handled. At the same time it is important that only No. 1 fruit be stored. Not only is there little profit in storing No. 2 fruit but when it goes on the market it hurts the sale of No. 1 fruit.

Certain differences in the management which the trees receive result in corresponding differences in the keeping quality of the fruit. For example, apples grown in sod attain to a higher color and keep longer than those grown under clean culture. The soil on which the tree grows makes a difference with the keeping quality of the fruit. Baldwins grown on sandy or gravelly soil ripen earlier and must be picked earlier and do not keep so well as those on clay soils, although they have a higher color.

The presence of fungi is liable to shorten the life of fruit. Fameuse and many other varieties when affected by scab keep very poorly in storage. Fruit affected by certain other fungi keeps well until it reaches a certain stage of ripeness and then goes down quickly. If Baldwins are very badly affected by fungus, they hold longest in cold storage if picked quite green. Fruit affected with fungus keeps best in a cold dry atmosphere.

But except for retarding the development of fungus, apples keep best with considerable moisture in the air. Such is the opinion of many storage men. In recent years cold storage men have generally come to believe that apples should go into storage as soon as picked. With the Hubbardston, however, it is no doubt best to let the fruit lie on straw on the ground for two or three weeks for the purpose of adding color to the fruit. This can be done, perhaps, with this variety because it is not a good variety for storing anyway and goes soon into consumption. But cold storage men are agreed that, although this practice may put the fruit in better condition for immediate use, it injures its keeping quality.

Some varieties, as McIntosh, ripen very unevenly. If all the fruit is picked from a tree of such a variety at one picking, there results a mixed lot of differing degrees of ripeness, and the season of the ripest fruits determines the season of the whole lot. The harvesting of such varieties should be divided between two or more pickings. In parts of the west, it has become an established practice to pick some varieties of apples in the same way that peaches and oranges are picked, going over the trees a number of times and taking each time only those fruits that have reached the required degree of ripeness. As a result the different fruits in any such lot are very uniform in keeping quality and the percentage of No. 1 fruit is greatly increased. The small packages used by Oregon fruit-growers for their apples and the high prices obtained for the fruit make the practice profitable there.

Some growers have, in the last few years, adopted the practice of picking early apples, especially Oldenburg, in this way, and the practice is gaining. In this case the earliness of the season gives time for several pickings; but when the main crop of fruit comes on it must be harvested all at once in order to get through picking in time. Although the desirability of making two or more pickings is commonly admitted it does not seem to be generally practicable under present conditions and methods of apple orcharding in New York State. The practice is for the grower of early or fancy fruit or of fruit for local markets rather than for the growers of the ordinary commercial varieties of winter apples. Yet there is a feeling, especially among dealers, that this is a coming practice.

It is a matter of common observation that specimens that are very large for the variety do not keep so well as those of medium size and firmer texture. This is remarked by several cold storage men. Such fruit may be produced on young trees or on mature trees making excessive growth or carrying a light crop.

Comparative Efficiency of Different Kinds of Storage.—The efficiency of the various kinds of storage as applied to different varieties differs greatly. For instance, according to Hart, the season of both Fallawater and Grimes in cellar storage is January; but the season of Fallawater in chemical cold storage is May, a lengthening of the season by 4 months, while the season of Grimes in chemical cold storage is February, a prolongation of the season of only 1 month. Again, the season of Missouri *Pippin* and York Imperial in cellar storage is given by Newhall as December; but that of Missouri *Pippin* under ice is April, a prolongation of the season by 4 months, while the season of York Imperial is extended only 1 month or until February. Nor is there any constant difference for all varieties in their season in storage under ice and in chemical cold storage. For instance, Graham gives the season of both Baldwin and Hendrick in storage under ice as May 1; but he gives the season of Baldwin in chemical cold storage as June 15, or an increase of one and one-half months, while the season of Hendrick is stated as May 15, or an increase of only one-half month. As to the difference in season of varieties in cellar and in chemical cold storage, Howes makes this uniformly 60 days, *i. e.* 2 months, for all varieties. Newhall makes it 1 month for 5 (early fall) varieties, 2 months for 19 varieties, 3 months for 23 varieties, 4 months for 8 varieties and 5 months for Northwestern *Greening*. Graham makes this difference variously from 5-6 month to 3 months. Hart makes this difference 2 months in a large majority of cases, with extremes of 1 and 4 months.—(N. Y. E. S. B. 248.)

INFLUENCES OF IMPORTANCE IN COLD STORAGE.

An apple usually should be fully grown and highly colored when picked, to give it the best keeping and commercial qualities. When harvested in that condition it is less liable to scald, of better quality, more attractive in appearance, and is worth more money than when it is picked in greener condition. An exception to the statement appears to exist in the case of certain varieties when borne on rapidly growing young trees. Such fruit is likely to be overgrown, and under these conditions the apples may need picking before they reach their highest color and full development. Uniform color may be secured by pruning to let the sunlight into the tree, by cultural conditions that check the growth of the tree early in the fall, and by picking over the trees several times, taking the apples in each picking that have attained the desired degree of color and size.

Apples should be stored as quickly as possible after picking. The fruit ripens rapidly after it is picked, especially if the weather is hot. The ripening which takes place between the time of picking and storage shortens the life of the fruit in the storage house. The fruit rots multiply rapidly if storage is delayed and the fruit becomes heated. If the weather is cool enough to prevent after-ripening, a delay in the storage of fruit may not be injurious to its keeping quality. A temperature of 31° to 32° F. retards the ripening processes more than a higher temperature. This temperature favors the fruit in other respects. A fruit wrapper retards the ripening of the fruit; it preserves its bright color, checks transpiration and lessens wilting, protects the apple from bruising, and prevents the spread of fungous spores from decayed to perfect fruit. In commercial practice the use of the wrapper may be advisable on the finest grades of fruit that are placed on the market in small packages.

Apples that are to be stored for any length of time should be placed in closed packages. Fruit in ventilated packages is likely to be injured by wilting. Delicate fruit and fruit on which the ripening processes need to be quickly checked should be stored in the smallest practicable commercial package. The fruit cools more rapidly in small packages.

They should be in a firm condition when taken from storage, and kept in a low temperature after removal. A high temperature hastens decomposition and develops scald.

The best fruit keeps best in storage. When the crop is light it may pay to store fruit of inferior grade, but in this case the grades should be established when the fruit is picked. The bruising of the fruit leads to premature decay. The scald is probably caused by a ferment or enzyme which works most rapidly in a high temperature. Fruit picked before it is mature is more susceptible than highly colored, well-developed fruit. After the fruit is picked its susceptibility to scald increases as the ripening progresses. The ripening that takes place between the picking of the fruit and its storage makes it more susceptible to scald, and delay in storing the fruit in hot weather is particularly injurious. The fruit scalds least in a low temperature. On removal from storage late in the season the scald develops quickly, especially when the temperature is high. It does not appear practicable to treat the fruit with gases or other substances to prevent the scald.

From the practical standpoint the scald may be prevented to the greatest extent by producing highly colored, well-developed fruit, by storing it as soon as it is picked in a temperature of 31° to 32° F, by removing it from storage while it is still free from scald, and by holding it after removal in the coolest possible temperature. A variety may differ in its keeping quality when grown in different parts of the country. It may vary when grown in the same locality under different cultural conditions. The character of the soil, the age of the trees, the care of the orchard—all of these factors modify the growth of the tree and fruit and may affect the keeping quality of the apples. The character of the season also modifies the keeping power of the fruit.—(B. P. I. B. 48.)

PEAR AND QUINCE.

Pear.—The common pear of commerce is descended from the wild *Pyrus communis* of Europe and Asia. The trees of this species are usually pyramidal in shape. Von Mons, in Belgium, early in the nineteenth century, probably did more to improve the pear than any other person. He originated many of the standard kinds grown to-day. The Japanese or sand pear (*Pyrus sinensis*) is a native of Asia. Its fruit is gritty, hard, austere, and of little importance commercially. However, it is very productive, healthy, and hardy to withstand wide extremes of temperature. The Kieffer, Le Conte, Garleer, and others have originated by combining the sand pear with the *Pyrus communis.* This cross constitutes a most important group commercially, for while the pears are inferior in quality to most of the standard sorts on the old list, the trees are exceedingly productive and the fruit is valuable for canning purposes. The great interest in pear culture in recent years has led to the introduction of a large number of new varieties, until now there are about a thousand kinds described.

Propagation.—(*a*) Pears are propagated by crown grafting in the field; (*b*) by root grafting in the house in winter on whole roots; (*c*) by budding in summer. The stocks commonly used for the pear are: (*a*) Seedlings of the small, crabby pears, which are common in Europe and are known botanically as the *Pyrus nivalis.* These produce a large amount of plump seed, and are vigorous and thrifty. Most of the stocks used in this country are imported from Europe, and trees worked on these grow into standard or large trees. The seedlings are not easily grown here, as they often blight in the seed bed. (*b*) Quince roots (*Cydonia vulgaris*) are used as stocks for dwarf pear trees. These stocks are grown by mound layering the Angers quince, and are afterwards planted out and budded. The union formed is quite permanent, although it is often marked by a considerable swelling. Some varieties do poorly on the quince, while others are improved both in productiveness and in quality of fruit. If dwarf trees are planted deep they throw out roots above the union and become standards. Dwarf pears have the merit of fruiting very young and heavily, often when only three years from the bud. They require the new wood to be shortened each year if they are to be kept in compact form, otherwise they grow too rangy. About 12 feet is the proper planting distance. (*c*) Thorns (*Cratægus*), mountain ash, and even shad bush (*Amelanchier canadensis*) have been used as stocks for the pear with fair results. It is quite common to use the mountain ash for this purpose in Sweden, where ordinary pear stalks are tender. The Japanese quince has also been tried, but does not form a permanent union. (*d*) The Kieffer pear is sometimes used for pear stalks, and for this purpose it is generally grown from cuttings. Its use is largely confined to the Southern States.—(U. S. E. S. B. 178.)

Soil.—In the matter of soils the pear is recognized as a fruit which is not very discriminating. The ideal soil for dwarf and standard pears is a clay loam, with a porous clay subsoil. The dwarf pear requires a moister, stiffer soil than the standard to secure maximum results, although even dwarfs may be made to succeed on sandy soils by heavy manuring and high cultivation. Sandy soils with clay subsoil often prove very good for the standards. Many of the pear orchards on the eastern shore of Maryland and at least a portion of those in New Jersey are on this kind of soil.

For the Oriental pears the light, sandy peach soils may be considered the ideal ones. The Oriental pears will grow and thrive on almost any soil which is not too wet; but for the highest perfection in quality of fruit and smoothness and high color of the skin they should be grown on rather light, porous, well-drained soil, and on high or sloping locations, where the air drainage is good. In other words, the Oriental pears reach their greatest perfection in localities and sites where the peach succeeds well.—(Y. B. 1900.)

Trees and Planting.—(*a*) Young, thrifty trees about two years from the bud are the best for planting. (*b*) Pears are generally placed 16 by 16 or 20 by 20 feet apart, according to the form and size of the varieties. (*c*) Pears bear paying crops younger than apples. This quality, however, varies much with the different kinds.

Pruning.—Pears need more pruning than apples when young. During the first few years after planting the central shoots that usually seem to attract all the growth should be pinched or shortened, except the one central shoot, which should be preserved through the life of the tree. Proper attention to this when trees are young will develop a head that will need but little training when the tree is mature.—(U. S. E. S. B. 178.)

Thinning the Fruit.—It is a great mistake to allow pear trees to overbear. When the fruit is about an inch in diameter the trees should be gone over carefully and all the surplus pears, over and above what the tree can mature properly, picked off. Each branch should be examined, and, with the size of the mature fruit in mind, the number reduced to the proper amount for that size of branch. All imperfect, wormy, or distorted specimens should be picked off first, and only those which are expected to make fancy fruit left behind. Unfortunately, no general rule can be given to guide in thinning pears. The rule of one fruit to 6 inches, which commonly guides the peach grower in thinning peaches, can not be definitely applied to pears. Experience is the only guide, and the grower may expect to allow a few trees to overbear before he learns the lesson of just how much to thin. Thinning not only improves the quality of the fruit of the current season, but it places the tree in better shape to bear the next year. As a rule, greater profits are secured by regular annual crops than by heavy crops during occasional years, for it commonly happens that such seasons are the very ones when fruit is plentiful and cheap and the profit in handling it very small.—(Y. B. 1900.)

Fruit.—The fruit varies greatly in quality. Some varieties are only valuable for cooking, and others are of finest dessert quality. In color pears vary from a beautiful yellow with pink cheek to dark, rough, deep-brown russet. In form they vary from globular through a great variety of shapes to the typical pear shape. In season of ripening they range from early summer to kinds that will keep in an ordinary cellar until March. The fruit should be protected by spraying, and should be picked when full grown even if very hard, as it is improved by being ripened under cover. Some varieties that water core badly on the trees are exempt from it when ripened under cover. They are on the market as fresh fruit, dried, or canned, and are used for making pear cider which is known as "perry."

Varieties.—The varieties selected should be such as are recommended by the local horticultural society ~~or~~ by the American Pomological Society. Farmers' Bulletin No. 208, by the U. S. Department of Agriculture, offers many suggestions. Care should be taken in planting to see that the self-sterile varieties are mingled with those that are self-fertile.—(U. S. E. S. B. 178.)

In considering the merits of varieties of pears that a grower contemplates setting, several factors need to be taken into consideration—productiveness, regularity of bearing, time of ripening, freedom from "knots," perishableness, and quality of fruit. If the pears are to be grown for market, external appearance must also be given due weight. Some varieties bear well, but the fruit is unfit for food, while other varieties produce good fruit, but in too small quantities.—(Ariz. E. S. B. 51.)

Commercial Classification.—From the standpoint of the commercial orchardist and for cultural purposes pears may be divided into three groups: Dwarf, standard, and Oriental. The dwarf pear consists mainly of European varieties propagated on the quince root, the principal stock used for this purpose being rooted cuttings of a vigorous variety called the Angiers. The trees so propagated are dwarfed in habit, and are usually very productive and precocious in bearing. In case of certain varieties, conspicuously the Angouleme, the fruit is improved both in quality and quantity. On the other hand, the quality of the Seckel is not so good on the quince. Occasionally we have the anomaly of a pear growing naturally as a dwarf when propagated on the pear root, an example of this being the Japan Golden Russet; but ordinarily speaking, the dwarf pear means the pear on the quince root. The second class, standards, consists of the European varieties propagated on the pear root. The stocks for this purpose may be either European pear seedlings, Japan pear seedlings, or rooted cuttings of some of the Oriental pears. The third group, Orientals, comprises those pears which are partly or wholly of Chinese or Japanese origin. Only a small part of the commercial plantings are pure Oriental pears. Most of the important commercial varieties in this group are half-and-half hybrids between the Oriental and the European pears. The Oriental blood, however, which is in them gives them such a strong constitution and makes them such vigorous growers that they stand out very distinctly from the European tribe. In all orchard considerations these three types of pears must be kept continually in mind, as their requirements are usually quite different. —(Y. B. 1900.)

COMMERCIAL PEAR CULTURE.

Picking and Marketing.—The methods used in marketing pears vary so greatly in different parts of the country that it would be impossible to describe them all in detail. It is only possible, therefore, to give certain general considerations in regard to the matter.

The season of the year, whether summer or winter, the distance from market, the purpose for which the fruit is intended, as well as many other conditions peculiar to the markets of different cities, all have their effect in determining the methods used by the successful pear grower. The California grower packs his pears, mostly wrapped in paper, in neatly constructed boxes, shipping them in carload lots to New York, Boston, or other Eastern cities, or perhaps to London. The fruit is sorted and packed directly after it is picked from the trees, and is expected to ripen in transit and open up in prime condition for eating 3,000 miles or more from the orchard. The grower of the Le Conte and Kieffer pear in the Gulf

States also packs his fruit in wholesale methods, using barrels or boxes, and ships it in car lots, or sometimes even in train lots, to Northern cities. On the other hand, the Eastern gardener may ripen up a few bushels in his house and deliver them direct to his retail or wholesale customers. Large quantities of pears are consumed by the canneries, both on the Pacific coast and in the Eastern States. The large crop of Kieffers, which is now getting to be such an important factor in the pear market of Eastern cities during the autumn months, is very largely taken up by the canneries, especially in Baltimore, and the trade in canned Kieffer pears is very rapidly increasing. For the canning trade the pears are almost always shipped in baskets of the type of the Maryland and Delaware peach basket, and the baskets are generally returned to the grower to be used over and over again. The price paid is usually so low that the cost of the baskets is an important item if they are not returned. The price is often as low as 15 to 20 cents a half-bushel basket, and 25 to 30 cents is considered a good price. At this price Kieffer pear growing is immensely profitable. This can be readily understood when the yield is often more than 1,000 baskets per acre.

One important point for the inexperience pear grower to determine is the exact time for picking the fruit. The pear is quite exceptional as compared with the ordinary orchard fruits in that it is much better if picked from the tree before it is ripe, and then ripened up either closely packed in a box or stored in large quantities in a tight room. Very few pears are at their best if allowed to ripen on the tree. As choice a pear as Clapps Favorite becomes dry and mushy at the core and very poor in quality if allowed to hang on the tree, while the same fruit, picked when firm and hard, but full grown, and ripened indoors, will be of an even consistency, juicy and delicious. During the last few days that the fruit hangs on the tree the development of the hard, woody kernels, the so-called stone cells of the pear, proceeds rapidly. Picking before the fruit is ripe seems to partly head off the development of these stone cells, and the subsequent ripening processes still further soften and disintegrate them. Among the pears of medium and poorer quality, such as the Duchess, Kieffer, etc., the ripening process may almost be said to make the fruit edible, at least make it fit for a dessert fruit. Kieffers allowed to hang on the tree until they are full colored and ready to drop have the maximum amount of stone cells; in fact the portion surrounding the core becomes almost a mass of woody matter under these circumstances. If, on the other hand, the fruit is picked when it first attains full size, or even a little before, and is ripened in bulk and in the dark, it will color up a beautiful delicate yellow, frequently with a red blush, and soften evenly throughout, making a fairly good pear to eat out of the hand and a most excellent canning and cooking fruit. Pears allowed to hang too long on the trees when they are apparently ripe and soft will be found to have merely a shell, about half an inch thick, of ripened pulp and a large central portion either too hard to eat or filled too compactly with stone cells.

Generally, pears may be divided into two main classes in regard to ripening methods, namely, summer pears and winter pears. All fruit ripened with or before the Bartlett may, for convenience, be classed as summer fruit, although of course in the Southern States autumn varieties of the North, like Seckel and Duchess, really are summer fruits. The summer pears require but a short time, on account of their perishable nature and the high temperatures prevailing at picking time, to reach an eating condition after they are picked. It becomes necessary, therefore, in most cases for the grower to pick the fruit and pack it at once into the packages and ship it to market. The fruit will even then arrive none too soon in most cases to suit the wholesale buyer. Summer pears should always reach the wholesaler in a perfectly hard, firm condition, or at most just beginning to become soft enough for eating. The retail dealer will, therefore, have time to handle the goods before they spoil. They will usually ripen up on his hands in ample time for him to sell them. The autumn and winter fruit, however, having much firmer texture and requiring longer to soften, should usually be partly ripened before it is started off to market. Pears like the Kieffer color up fully before they are soft enough to eat, and can usually be shipped to the commission houses while full colored, yet perfectly firm and sound. As a general rule, summer and fall pears should be picked from a week to ten days before they would ripen on the tree. The grower determines this point by several kinds of indications. In the first place the size and appearance are guides to him. As the fruit approaches maturity the dead-green color of the immature fruit is replaced by a clearer, more transparent, and lighter-green appearance, which has to be seen to be fully understood. Again, certain wormy specimens attacked by the codling moth will begin to color up and fall from the trees. These are a sure indication that the normal pears will ripen shortly. Upon taking hold of the fruit and lifting it gently, if it is approaching maturity and ready to pick, the base of the stem will part rather easily from the twig at the proper separating point. If the fruit is immature the stem is apt to break at any place, although it may break off at the joint, but the ease with which the stem parts from the twig is a very good indication of maturity.

Pears should always be picked carefully, without bruising, with the stems on. They should be laid carefully in the picking baskets, which should hold half a bushel or so, and then be hauled to the packing house or other convenient place and at once sorted into grades, and either packed and shipped or placed in the ripening house for future shipment. It is usually better in most cases, especially with summer fruit, to pick the trees over two or three times, although this is not absolutely necessary, and unless the trees are heavily loaded may not be worth while. When the fruit has not been properly thinned and the trees are overloaded, many growers begin to pick the fruit long before it is full grown and send it to market. By this means the trees are not only relieved somewhat, but the fruit that is left swells to the largest possible bulk; moreover, satisfactory returns are often secured from the early pickings. This method is particularly successful with Clapps Favorite and Bartlett. Both of these varieties will ripen up tolerably well when they are not much more than half grown. The same principle is successfully used in handling Le Conte and Kieffer pears, but these should be nearer maturity to be good. There is one great advantage in the application of this principle of premature picking in case of these two great varieties, in that it distributes the marketing season over a longer period, and thus tends to give the country time to consume the crop without any glut in the market.

A Kieffer orchard skillfully managed, therefore, may be picked over in the latitude of Maryland about September 15, and then successive pickings may take place for three or four weeks. The earlier picking will be marketed and sold while the later fruit is still on the trees, and by a little attention to storing the later pickings in a cool place the fruit may be marketed from September 20 to Thanksgiving time or later without cold storage. Cold storage, of course, still further lengthens the possibilities of the marketing season for any given variety. Pears may be put in cold storage in about the same way as apples, the temperature required varying from 33° to 38° F. They are usually stored at a temperature a few degrees higher than that in which apples are stored, in fact are given the treatment of summer rather than winter fruit. Unfortunately, pears do not stand cold storage as well as apples. This is especially true of summer pears. Extra precautions are necessary in both picking and handling the fruit before it is put in storage, and in the subsequent handling after it is taken out. Cold storage pears are very apt to blacken and become unsightly after they are taken out of storage, even though they may be in fairly good condition. Summer pears, particularly, are inclined to lose their flavor in cold storage. Kieffer, Anjou, Bosc, Easter, and some other late varieties when put into cold storage hard and green seem to stand the treatment very well and come out several weeks afterwards in nearly the same condition as that in which they went in. They may then be brought into a warm room for a few days before they are wanted and ripened up nicely for eating.

The packages used for pears vary widely in different parts of the country. As before mentioned, the half-bushel peach basket is very commonly used in handling the crop for delivery to canneries in Maryland, Delaware, and New Jersey. This basket usually goes under the name of the five-eighths basket. Very few of the models, however, hold five-eighths of a bushel. This basket with a slatted cover is also very largely used in shipping by steamer and otherwise to Baltimore and Philadelphia. It is in some respects the least desirable package of all except in cases where the grower can haul the fruit direct to the city markets, or where cars can be filled by packing the entire car tightly with the baskets. The pear box, usually with a middle partition and holding from 3 pecks to a bushel, is very commonly used in the Eastern States. Some very rough specimens of this type of package, made of undressed laths with wide spaces between, annually reach the markets of our Eastern cities, and as the package commonly sells the fruit, low prices may always be guaranteed for such a package, regardless of its contents. On the other hand, the pear box on this model made of neatly dressed half-inch pine or similar wood, can be made really a fancy package, and if the fruit is wrapped in paper, and carefully sorted and packed, it may bring the best prices in the market. In New York State and New England bushel kegs are very largely used for shipping Bartlett, Anjou, and other pears. A still larger package is the pear barrel, a special barrel made for shipping pears, smaller and with less bulge than the apple barrel, and holding about 2¼ bushels. Kieffer pears, and very commonly the Southern Le Conte pears, are frequently shipped in regular apple barrels.

If the grower ships to a commission house, it will be wise to consult the commission merchant as to the form of package which suits the market demands of his city for the different grades and varieties of his fruit. It is very often wise to put up the fancy fruit in a fancy and perhaps small package and to put the poorer grades into larger and cheaper packages. Usually nothing is gained by deception in packing the fruit, especially if the grower expects to use the same market repeatedly and to sell to the same consumers. It is usually best to have a distinct brand or trade-mark if any considerable quantity is to be sold. If the fruit is really meritorious, grocerymen and other fruit buyers will quickly become familiar with this mark and will come back and call for it again. Fruit which is known by a brand will often sell readily and quickly for 50 per cent more than other fruit equally as good, but not known to be so by the buyer.—(Y. B. 1900.)

QUINCE.

The quince is a native of Asia and southeastern Europe, and is descended from the *Cydonia vulgaris*. The quince is propagated: (*a*) By cuttings of the new wood planted in autumn and from cuttings of the surface roots. (*b*) By mound layering. (*c*) By budding and grafting the cultivated varieties on the free-growing Angers quince. (*d*) By grafting long quince scions on short pieces of apple roots, which are broken off after one year. This method is successful with some varieties that do not grow easily from cuttings. The quince is also used as a stock for dwarfing pears. Rich, moist, not wet soil is best. (*b*) Plant about 12 by 12 feet apart. (*c*) Avoid much stable manure, as it has a tendency to encourage fire blight. Maynard recommends 300 to 500 pounds of sulphate of potash and 500 to 1,000 pounds of ground bone per acre as a fertilizer. Little pruning is required except to keep the suckers off the trunk and roots. The trees should branch close to the ground. The fruit should be picked when it begins to turn yellow. It requires great care in handling, as it bruises easily, but will keep a month or more. It is used mostly for canning.—(U. S. E. S. B. 178.)

Notes on Varieties.—Alaska—Not so large as Orange, otherwise not very different from it. Orange—Large, yellow; quality good; productive and a valuable market variety. Meech—Of medium size;

A Mountain Apple Orchard, Sharp Peak, Va. Dept. of Agr.

very late in ripening and does not color very well; very productive but the quality is only fair. Missouri—Of the largest size and a good quality. The earliest ripening variety; moderately productive. Rea (Mammoth)—Very large; yellow; fine quality; vigorous, very productive. A seedling of the Orange but a larger and finer quince than that variety.—(Mich. E. S. B. 27.)

PEACH.

There is so much intermingling of families among cultivated peaches that they are difficult to separate. They, however, have been classified in a general way, as follows: (*a*) The Peen-to group or flat peaches, represented by the Peen-to variety and grown mostly in the South. (*b*) The South China group, having long pointed fruits with a deep suture near the base. Example, the Honey. (*c*) The Spanish or Indian group, having very late yellow, firm, and often streaked fruits; grown in the South. Examples are the Lulu and Galveston. (*d*) The North China group, having very large fruits and leaves and clingstone fruit. Represented by the Elberta and Smock. (*e*) The Persian group, the common peach of the North. This group includes the Crawford, Salway, Old Mixon, and others.—(U. S. E. S. B. 178.)

PEACH REGIONS.

The peach is very susceptible to spring frosts and very partial to those situations where its buds will not start during warm winter days to be killed by sudden freezes or frosts. For this reason it thrives best where it is under the moderating influence of large bodies of water. In the northern and eastern states the regions noted for their evenness and mildness of winter temperatures are best for the peach. These are chiefly close to the great lakes and to the sea coast. Thus we find a great peach belt on the eastern shore of Lake Michigan where the prevailing winds from the water moderate the climate very much. Commercial orchards are extensive along lakes Erie and Ontario. Along the Atlantic seaboard, the most noted peach areas are in Connecticut and southward to Maryland's eastern shore. From this middle seaboard region the peach thrives inland to the mountain regions of West Virginia. Extensive orchards are also found in Georgia and the northern part of Alabama, Eastern Texas, southern parts of Kansas, Missouri and Illinois; and the milder parts of California and Oregon. The peach has its limits in latitude. Northward it does not pay well beyond 44 degrees and then only in the vicinity of water as in Michigan and Oregon. Southward it is limited by the attacks of a root disease which in our latitude is killed in winter by freezing.—(W. Va. E. S. B. 82.)

The peach districts of America are also outlined in Farmers' Bulletin No. 208 by the United States Department of Agriculture. The peach is propagated as follows: (*a*) Seed. Some varieties of the peach come so nearly true from seed that they are thus propagated, but it is an uncommon method with commercial varieties. (*b*) Budding is the common and almost the exclusive method in practice in the North. (*c*) Grafting the peach is practiced in California and in the South. (*d*) Peach seed must be stratified over winter. It should be examined before planting in the spring and those pits that are not cracked by frost should be broken by a hammer. Stocks—(*a*) Seedlings from natural fruit are preferred, i. e., those which have not been worked and from sections where the peach is healthy and free from yellows. A favorite source of peach stock is in parts of Tennessee and Kentucky where the peach grows in thickets. (*b*) Plum stocks are sometimes used for the peach where it is grown in heavy moist soil, but is seldom used in commercial peach growing. (*c*) The peach buds easily. The seedlings should be worked the first season, when they will be 18 to 24 inches high. If the stock is larger, the buds will grow too large the first year.—(U. S. E. S. B. 178.)

ESTABLISHING AND MANAGING PEACH ORCHARDS.

Select a proper site for the orchard. Avoid lowlands and sites much exposed to severe prevailing winds. Choose a well drained soil though not one likely to suffer from drought. Avoid wet soils or fields with wet portions even if they lie at some elevation. Select varieties which will be likely to suit your conditions of soil, market and system of management. In general, choose standard sorts which have shown their worth. A list of standard sorts is as follows: Greensboro, Carman, Mountain Rose, Champion, Belle of Georgia, Elberta, Fox Seedling and Steven's Rareripe. Mountain Rose lacks shipping quality and is quite susceptible to rot except under favorable conditions. Because of its season of ripening, however, it has often found a strong market. Champion is also quite susceptible to rot except under the most favorable conditions. Other sorts which have proved profitable in some localities are Old Mixon, Iron Mountain and Reeve's Favorite. Niagara is one of the promising new varieties.

Order the trees several months in advance of the time when they will be needed for planting. When placing an order, state definitely not only the number of trees of each variety wanted but also the grade of trees desired in terms of *height* and *caliber*. Always plant one-year-old trees. These are much to be preferred to June buds. Two-year-old trees should not be purchased. Vigorous, compact, medium to large, one-year-old trees are the best to plant. Avoid weak trees and any that are severely injured by borers or affected with root gall. Do not pay excessive prices for trees of standard varieties. When the trees arrive from the nursery unpack them at once; note if your order is properly filled, and if the roots of the trees are dry they should be placed in water for a short time. If they should be infested with root aphis, dip in a whale-oil soap solution, made up at the rate of one pound of soap to three gallons of water. Before planting the trees examine them carefully for borers and destroy any which may be found. Do not set weak or severely injured trees. If the soil is not frozen, take the trees to the site of the orchard, prune them and heel them in; they will then be ready for setting when needed. In pruning, cut back the trees so they will not be higher than two feet above the point where they were originally budded. Prepare the soil by thorough plowing and harrowing as soon as the land is in condition in the spring.

Lay out the orchard in good form, leaving plenty of distance between the outside rows of trees and any enclosing fences, hedgerows or woodlands. Set the trees from seventeen to eighteen feet apart each way for average conditions; upon rich sandy loams twenty feet would be the best distance. Where a system of close pruning is practiced, sixteen feet may prove sufficient but is not recommended for the average grower. Plant the trees as early as the land can be properly prepared. Set the trees firmly and in straight rows. Plant them slightly deeper than they stood in the nursery. Unless the soil has previously been limed, apply from 2,000 to 3,000 pounds of ground limestone or ground oyster shell lime to the sandy soils, and 2,000 pounds per acre of burnt lime to the heavier soils previous to setting the trees into the orchard. It is recommended that all fertilizers be applied broadcast and plowed under early in the spring. Vegetable crops may be grown between the rows of newly planted trees the first season, if desired, but any crop which will prevent thorough cultivation to destroy weeds and conserve moisture will prove injurious to the trees.

Under average conditions a crop may be grown between the rows of trees in the peach orchard the first year that will at least pay for the expense of the cultivation of the orchard. The initial cost of the trees, pruning, "heeling in," setting and leveling the orchard by harrowing should not exceed a maximum of $20 to $25 per acre, unless land is exceedingly stony. Do not summer prune the trees the first season unless they are making an exceptionally strong growth, and then only to correct irregular growth.

Upon average soils trees of the variety of Elberta should make an average total growth of at least from 300 to 400 inches, and large trees under such conditions will often make a total growth of from 600 to 800 inches. Vigorous, rapid growing varieties, such as Early and Late Crawford, Carman and others, should make an average total growth of from 400 to 500 inches. Peach trees set early upon rich soils sometimes make a total growth of from 1,200 to 1,300 inches if well cultivated. A cover crop should be sown in the orchard to act as a cover to the soil during the winter to prevent washing and leaching and to furnish organic matter and to make plant-food more available. Just before the ground freezes in the fall the soil should be mounded up about the trees to ensure against winter injury to the bark at the collar. An orchard that is poorly planted and carelessly managed the first year is often an irregular, unprofitable orchard for its entire existence.

Summary.—The first important operation in the peach orchard the second season is the pruning of the trees. A few important principles of plant growth are appropriate to precede a specific discussion of the pruning of one-year-old peach trees. To secure successive yields of fine fruit there must be a proper balance between the processes of vegetative growth and fruit production. Excessive leaf and wood growth is always at the expense of fruit production. Abundant fruit production is a direct demand upon the vigor and life of the tree. Pruning during the dormant season encourages vegetative growth. Weak trees may be invigorated by proper pruning when dormant. An excessive wood growth may be induced upon vigorous trees by a too severe pruning during the dormant season.

Lack of pruning is frequently responsible for fruit of small size and indifferent quality; for an expensive type of tree for spraying and harvesting of fruit; for a lack of economy of the vigor and resources of the tree which can be directed toward fruit production; and for premature old age and final destruction of the tree. Proper pruning tends to conserve and promote the vigor of fruit trees. A certain amount of light is essential to the production of fine fruit. To secure a maximum crop of fine fruit it is necessary that each tree should have a maximum amount of vigorous fruit bearing surface. *To secure a uniform orchard of trees of good form it is necessary to practice a certain amount of pruning and training from the beginning.* To prune a one-year-old peach tree, *first select the best two, three or four main branches that tend to form the strongest, the most symmetrical and best balanced tree.* Cut off all other main branches close to the trunk. Retain those particular secondary or side branches which, by their position and vigor, tend to form an ideal framework for the support of the fruit bearing surface of the tree. Where two branches occupy much the same space one should be removed. All branches which cross and encroach upon the space due to others should be pruned out. The principal objects in cutting back the branches of one-year-old peach trees may be briefly expressed as follows: (1) To correct an irregular form and habit of growth and thus secure a better balanced tree. (2) To secure a more spreading type of tree by a proper checking of the upright tendency of growth of the central leading branches (especially of upright growing varieties). (3) To develop a stronger and more compact tree. (4) To promote a more vigorous growth where there is a lack of vigor or winter injury to the twigs. A slight cutting back of the twigs is beneficial to one-year-old peach trees. *Severe cutting back is only proper when the trees are weak, irregular or of an undesirable form.*

One who really understands pruning should be able to prune from seventy to eighty average one-year-old trees per hour without difficulty. A man of ordinary pruning ability should be able to prune from fifty to sixty trees per hour unless they are unusually large.

For average good soils it is recommended that the following kinds and amounts of fertilizers per acre be applied early the second season and plowed under:

Sulfate or Muriate of Potash............	150 lbs.
Ground Bone	100 "
Acid Phosphate	200 "

Where the soil appears to be deficient in nitrogen, and especially if the trees fail to make a satisfactory growth the first season, it is recommended that 150 pounds of nitrate of soda per acre be added to the above formula. The orchard should be plowed as early in the spring as the soil conditions will permit. Put the soil in fine condition by harrowing, and keep a fine surface mulch by frequent harrowing until midsummer. Moisture and plant-food are essential to the trees. Weeds rob the trees of both plant-food and moisture.

Some summer pruning of young peach trees the second season is likely to prove both beneficial and economical. The objects of summer pruning are as follows: To improve the form of the tree. To remove suckers and undesirable branches which tend to make the head or top of the tree too dense. To remove the necessity for too severe winter pruning. To encourage and induce fruitfulness. The pinching back of irregular or too rapidly growing shoots should be done early in June. Suckers and undesirable shoots can be removed at any time.

Summer pruning is of especial value in correcting an irregular type of growth; in thinning the top of a tree which is becoming too dense; in checking a too rapid development in any direction; and securing uniformity among the individual trees in an orchard. A vegetable crop may be grown between the trees the second season if the soil is in a good state of cultivation. If the land is poor, weedy or very stony it is usually better economy not in intercrop. A cover crop should be sown in the orchard the second season. It will tend to prevent washing and leaching of the soil, winter injury to the trees, and will improve the character and condition of the soil. See that the soil is well up around the trunks of the trees before freezing weather in late fall. Never allow even a portion of the main root to lie exposed to the weather during the winter. Give the orchard its due attention at the proper time for economy and profit.—(N. J. E. S. B. 231.)

Summary of Suggestions to Growers.—The peach normally makes about four-fifths of its wood growth by midsummer. Cultivation for the sake of the tree should, therefore, be done early in the season. By the end of July the flower buds begin to form in the South, and in the North by September. Dormant, well-ripened flower buds will stand a temperature many degrees below zero, when less mature buds may be killed by even zero weather. There is a marked difference in the hardiness of different varieties, those of the Peen-to race being the tenderest and those of the Persian race the hardiest.

The pistil of a flower bud is the first to show injury from freezing, taking on a brownish or blackened appearance. The buds swell and blossom when conditions above the ground are favorable. Blooming is in a large measure independent of root action. Early varieties generally bloom later than late varieties. Peaches appear to be quite generally self-fertile. In localities where flower buds are normally killed by cold a crop can generally be secured by laying down the trees on the approach of winter and protecting with a light covering until danger from frost is past in spring. Whitewashing is a cheap method of retarding the swelling of fruit buds in the winter and delaying blooming in the spring. Winter injury is most severe in orchards or individual trees of low vitality induced either by lack of cultivation or fertilizers, the attacks of insects or diseases, overbearing, poor physical condition of the soil, drought, excessive moisture, etc.

A mulch of weeds, grass, cover crops, manure, etc., greatly lessens the winter injury over that in orchards on bare ground. To avoid winter injury to the greatest extent such thorough cultural practices must be maintained as will keep the trees in a vigorous, thrifty condition all the time. The fertility and vegetable matter of the soil must be maintained by the addition of manure or the growing of cover crops, and spraying to control insect pests and fungus diseases must be thorough and unremittent.

It is difficult to tell by the examination of fruit trees the extent of any winter injury. Trees which, examined in the winter, seem to be dead beyond doubt frequently recover. The best treatment for old trees appears to be medium pruning—cutting back the limbs into 2 or 3-year-old wood. Much more severe pruning may be practiced with young trees than with old ones. Good cultivation and light fertilizing should follow to help the trees overcome the injury.

The peach normally should be pruned back each spring from one-half to two-thirds of the previous season's growth, otherwise trees with bearing wood far out on the ends of the branches and naked trunks below will be produced. When the fruit buds are winter-killed, advantage should be taken to prune more severely in order to keep the tree in a compact form, with the fruiting wood near the ground. Old trees may be rejuvenated by severely pruning back part of the limbs each year. Seedling peach trees are best for nursery stock. Sand cherry (*Prunus besseyi*) is a good dwarfing stock. On alkali soils plum stocks appear to give better results than peach stock.

In transplanting nursery stock to the orchard the roots may be profitably pruned back from 5 to 8 inches in length and the trunks left from 16 to 24 inches long. The peach orchard should be so treated that the wood and buds will be thoroughly dormant when winter sets in. Cover crops other than the legumes planted in midsummer seemed to favor early ripening of the wood. In dry regions the cover crop should be one that will stand up during the winter, catch and hold the snow, and also be killed by the first fall frosts so that all the moisture of the soil may be left for the use of the tree during the winter. Trees on high land appear to ripen up earlier than those on low ground. Winter irrigation seems to be a desirable practice in some of the more arid Western States.

Peaches require as heavy fertilizing as wheat. They may be profitably fertilized when planted on land that would normally yield 40 bushels of corn per acre. The profitable bearing age of the orchard may be prolonged several years by the use of fertilizers. Peaches draw specially heavy on the nitrogen and potash of the soil. Thinning peaches is a desirable commercial practice in seasons of great abundance. It should follow thorough cultivation, manuring, and spraying. The benefits arise primarily from the larger amount of fancy and first-class fruit. Thinned trees appear also to develop more fruit buds than unthinned. Much of the thinning can be done by spring pruning, either before or after the fruit is set. Six to ten inches apart is close enough for the fruits to remain on the branches.

Peaches for market should be left on the tree until they have attained full size and are well colored but still firm. They ship best if cooled before putting on the cars. Thus harvested, carefully handled, and placed in cold storage at 32° F. in small packages they may be safely kept for three weeks, after which the quality rapidly deteriorates. A bushel of peaches will fill, on the average, sixteen 3-pound cans.—(U. S. E. S. R. 1906.)

COMMERCIAL PEACH ORCHARDING.

Success and Failure.—In every region in which there are peach growers and peach orchards, two facts are strongly impressed: First, that there are many farmers who have not found any crop in their experience that can yield them so large a profit as peaches, and their orchards receive their best care and are a delight to the eye Second, that there are also many farmers who have never had a dollar returned for their investment in peach trees and labor of planting them; their orchards are grown up with weeds and grass, dead and half dead trees predominate, the principal crop from the land is of weed seeds, peach yellows and borers. It is the universal opinion of successful peach growers that the price of their success was "eternal vigilance." They are frequent and thorough in the search for borers. They are convinced that tilling the soil during the entire life of the orchard is the best fertilizer. They exterminate diseased trees before the contagion spreads. They thin the fruit of overloaded trees that every peach may be perfect. These two kinds of farmers are often neighbors, with their orchards in view of each other, so that a difference in soil or atmospheric conditions cannot be claimed as the cause for the great difference in results. A farmer contemplating the planting of peaches should carefully study cases of failure as well as he does the cases of success and be thoroughly forewarned of the danger which lies before him and thereby be forearmed against it.

There is considerable uncertainty or variability in the quantity of a crop of peaches as well as in the price that can be obtained for them. This uncertainty and the utter failures in cultivation will tend to preserve the markets for the wide-awake and venturesome who can face the discouragements of an off-year.—(Pa. E. S. B. 37.)

Varieties.—Too much attention cannot be given to the proper selection of varieties. The number of varieties to be used will depend largely upon the method of marketing the fruit. If shipments are to be made in iced cars, care should be taken to plant enough of one variety, or of two ripening at the same time, to fill one or more cars at a time, as freight rates are much less than express rates. If the fruit is all to be hauled to near-by local markets a few hundred trees of a kind may be enough, and possibly ten or more varieties will be wanted.—(W. Va. E. S. B. 82.)

Harvesting and Marketing.—Peaches are commonly packed in the Delaware peach basket, called the one-half bushel basket, holding ⅝ bushel, and the peach crate, sometimes called the Pennsylvania crate, having a capacity of ⅞ bushel, divided into two-sections. The basket is used by some growers exclusively. The baskets are commonly used for local markets or for shipping the finer quality of peaches, and the crates are preferred for large shipments, because they pack into cars to better advantage. Growers realize that peaches must be put up in the most convenient and attractive packages to suit the purchaser to insure ready sale, and therefore the Florida crate, constructed to hold six baskets, without handles, each having a capacity of about 10 lbs. of peaches, are used to ship the best quality of peaches to such points as New York, Philadelphia, Baltimore and Washington. Another form of package is the Michigan basket, having a handle and a raised lid and a capacity of 20 pounds of peaches. The use of these smaller packages brings greater profits. Many a small basket of peaches would be carried home in an evening by purchasers as is now done with grapes because they are attractively packed and convenient to handle. Peaches are often refused because the dealer will not break a crate when the purchaser wants only a peck or half peck for a small family. Too many peach growers do not grade their peaches and therefore their city dealer grades them as having only inferior fruit to be sold accordingly. It is in grading the fruit that the shipper makes and preserves his reputation and by this means he receives the phenomenally large prices while his careless neighbor complains of low prices. The fruit should all be in the same stage of ripeness carefully laid in the basket so that there will be no settling during handling, and no imperfect fruit should be put in the first grade lot. All inferior fruit should be kept at home and whatever cannot be used at the evaporator or canned should be fed to hogs.

There is a proper time for the picking of peaches, which can be determined only by experience. The fruit on a given tree does not all ripen upon the same day and therefore cannot be picked at one time. Three or four pickings over the same variety must be made to put the fruit upon the market in the best condition, and thus green fruit and over-ripe fruit is avoided. If the fruit has been properly thinned after the June drop, there is but little work of selection necessary, but if this important operation was neglected, there will be an abundance of second class fruit. The fruit is usually picked in the half bushel peach baskets and too often receives no further attention than to be covered and shipped. They should then be assorted in the orchard or after hauling to the packing house or shed and handled from one basket to another as if they were eggs. This work cannot well be entrusted to hired labor, but must be reserved by the grower, who should be able to testify to the quality of every peach in the crates bearing his name.

The hauling of peaches should be done upon wagons with springs, and the greatest haste compatable with the necessary care should be exercised to put the fruit on its way to market. Many large peach growers have their orchards twelve or fifteen miles from the nearest shipping station, with the ordinary country roads, which, however, are likely to be at their best in the peach season. The expense of hauling a large number of crates ranges from one to two cents per crate.

Fruit which has become too ripe for shipping at the time it is picked or such as has a blemish should be used at home. Good fruit also which does not find a more profitable market should be canned or evaporated.—(Pa. E. S. B. 37.)

CANNING PEACHES ON THE FARM.

With the simple equipment by which it is possible to do good work in canning, only a relatively small investment is required. The quantity of fruit saved in a single season is often sufficient to more than pay for the whole cost of the equipment. If a grower is equipped for canning peaches he not only provides a way to protect himself when market conditions are unfavorable, but he has a ready means of using his poorer grades which, if shipped, as they commonly are, frequently bring only small prices at the best and at the same time depress the markets and reduce the prices for the better grades. Still other growers who have developed peach orchards where shipping facilities have proved inadequate, or where the orchards are isolated, or where other conditions have arisen which render the marketing of the fresh fruit unprofitable, have obtained satisfactory returns by putting the crop on the market in canned form at a later time.

In some sections of the country, particularly through the South, "home canners" are in common use. It is believed that their use could be greatly extended with profit and satisfaction to fruit and vegetable growers, not only in the South, but in other sections of the country as well. The quantity of fruit to be canned determines very largely the extent and character of the equipment that will prove efficient and at the same time economical. A canning outfit selected primarily for handling peaches, once obtained, will often be found useful for the canning of other farm and garden products. For most fruits, and some vegetables, nearly the same equipment will suffice as for peaches, but for others, especially for most vegetables, certain additional articles will be desirable. Many manufacturers furnish the necessary accessories and some include them in the prices ordinarily quoted for their outfits. Some also furnish with their outfits printed instructions which contain much information about the canning of fruits and other products that is of value to those who are not familiar with the operation.

Maturity of Fruit for Canning.—To be in the best condition for canning peaches should be well ripened, but still moderately firm. If too soft the fruit will not retain its shape in the cans, but will become more or less "mushy," thus injuring its appearance when the cans are opened. Soft fruit, canned in order to save it, should not be put on the market as "extra" grade goods, or the reputation of the one who canned it will suffer. Fruit of different degrees of ripeness or of different texture should, therefore, not be mixed, but each lot of the same degree of maturity and the same texture should be handled by itself.

The number of cans which a given quantity of fresh fruit will make depends upon several factors, such as the grade, size, and consequent proportion of waste in pits and skins, closeness of the pack in the cans, etc. Most estimates, however, place the quantity at from 18 to 20 No. 3 cans per bushel for fruit that is of good size and grade.

Preparing the Fruit for the Cans.—The first steps in preparing the fruit for the cans are to remove the skins and pits. All grades for table use should be made up of peaches that have been halved, the division being made through the suture. The halving is done in connection with the removal of the pits.

If done by hand it matters little with freestone varieties whether paring is done first, followed by halving and pitting, or vice versa. But with clingstone varieties a finished product of probably finer appearance can be produced if the fruit is halved and pitted before it is pared. The tight gripping of the halves, which is necessary in removing the pits, may result in the flesh being more or less bruised and crushed unless the skin is allowed to remain in order to give some protection to the fruit.

The paring, if by hand, is usually done with sharp straight-backed knives, care being taken to remove only a very thin and even peeling in order that the flesh of the fruit shall be smooth and attractive in appearance. The pits of freestone varieties, after the fruits are halved, may be removed with the point of a knife or with the fingers. A pitting spoon is desirable for removing pits from clingstones.

Filling the Cans.—The fruit should be put into cans as soon as possible after the freshly cut surfaces have been exposed to the air. Otherwise the surfaces turn dark and become unattractive in appearance. Filling the cans with the table grades is generally done by hand. The halves are put into the cans usually flat or pit side down, each piece being placed with considerable care so that the contents of the can will be fairly solid and to insure a uniform content as to quantity of fruit in each can. The cans should be filled very nearly full of the halved fruit. They are then ready for the next step.

A boxlike device is sometimes used as a filler to facilitate the work of putting pie peaches into No. 10 cans. This device has a depth of 6 or 8 inches, and is constructed with holes in the bottom which correspond with the holes in the tops of the cans when a particular number of them are arranged in a certain definite order. The fruit is poured into the filler, from which it drops or is readily pushed into the cans.

Marketing the Canned Product.—It is obvious that the financial success of this method of handling a peach crop, or any portion of it, depends upon the placing of it on the market at a satisfactory profit. As a rule, home-canned goods, if of good quality, find a fairly ready sale. They are commonly sold on sample to retail grocers and provision dealers. Comparatively large quantities can frequently be sold directly to consumers. A wisely placed advertisement in a local or county paper may also help in making sales. If a large quantity of fruit has been canned, it may be of advantage to sell through a jobber or a broker who handles canned goods.

The cans are generally packed in cases for the trade. The ordinary case holds two dozen No. 3 cans placed in two tiers, one dozen in each tier. The usual case for No. 10 cans hold one dozen. These cases may be obtained from the manufacturers of cans, as previously stated, or in shook form from various box and package manufacturers.

In this connection attention should be called to the federal food and drugs act in its relation to the labeling or branding of canned goods that enter interstate commerce. Any statement that is stamped or printed on the cans or on the cases in which they are packed regarding the weight, identity, quality, or place of production which is misleading constitutes, under the terms of this act, a misbranding of the goods. All requirements of the food and drugs act which should be considered in canning peaches may be ascertained by addressing the Board of Food and Drug Inspection, Department of Agriculture, Washington, D. C.—(F. B. 426.)

PEACH KERNELS.

Peaches are produced much more generally in the United States than apricots, although in the California fruit regions much larger quantities of the stones are accumulated at canneries and drying grounds than elsewhere. A rough estimate of the quantity of peach pits obtained as a by-product from the peach industry in California alone during a normal year is 10,000 tons. The ratio of the kernel to the pit in this instance is much less than in the case of apricots, probably varying from 6 to 12 per cent; the California crop should therefore net from 600 to 1,200 tons of peach kernels a year.

The amount of fixed oil obtainable from these kernels by expression is approximately 210 to 420 tons. The amount of volatile oil from the press cake, calculated from a yield of 1 per cent, would be from about 7,800 to 15,600 pounds. At the present time peach pits are not cracked nor the kernels exported to any great extent. Allowing a small quantity for use by nurseries, the remainder is chiefly used as a fuel, commanding from $5 to $7 a ton for this purpose. A more economical disposal of these kernels, so rich in fixed and volatile oils, might well be made in the United States by the growers and producers.—(B. P. I. B. 133.)

NECTARINE.

The nectarine is a smooth-skinned peach. It is interesting to know that peaches have been grown from the seed of nectarines and nectarines from the seed of peaches. The fruit is usually inferior to that of the peach in size, quality, and appearance. It is grown the same as the peach but not nearly as successfully. It seems to do best in the Pacfic coast States.—(U. S. E. S. B. 178.)

APRICOTS.

The apricots is like the peach in some respects, while in others it is like the plum. It resembles the former in flavor, in the shape of its fruit, and in being sometimes downy; but in the broad leaves of the trees and smooth stone of the fruit it is more like the plum. Generally speaking it is as hardy as the peach, and under the same general cultivation and care, the apricot may be expected to grow where the peach grows. The apricot is not grown so extensively as the peach. In California, however, where it is one of the leading commercial fruits, it has been extensively planted, owing to the thriftiness of the tree and the excellence of its fruit and its general adaptation to the climate. The apricot is naturally a rapid and vigorous grower, usually of an upright and spreading character, with a somewhat uniform head, making it one of the most beautiful orchard trees.—(N. M. E. S. B. 39.)

Apricot Kernels.—The kernels are largely exported to Europe, and especially to Germany, where they are used for various purposes, principally, however, according to reports noted, for the manufacture of the fixed and volatile oils. Only a portion of the yearly output of kernels from California is consumed in the United States, and that probably only for confectioners' purposes.—(B. P. I. B. 153.)

PLUMS.

The plums cultivated in the United States belong to the following groups:—I. Domestica or European types, *Prunus domestica.* Native to western Asia. Comprises the common or old-time plums, such as Green Gage, Lombard, Bradshaw, Yellow Egg, Damsons, and the like. The leading plums from Lake Michigan eastward and north of the Ohio, and on the Pacific slope. II. The myrobalan or cherry-plum type, *Prunus cerasifera.* Native to southeastern Europe or southwestern Asia. Much used for stocks upon which to bud plums, and also the parent of a few named varieties, like Golden Cherry; and DeCaradeuc and Marianna are either offshoots of it or hybrids between it and one of the native plums. III. Japanese types, *Prunus triflora.* Probably native to China. The types seems to be generally adapted to the United States, and will certainly be of great value to both the south and north. IV. The Apricot or Simon plum, *Prunus Simonii.* Native to China. Widely disseminated in this country, but little grown except, perhaps, in parts of California. V. The Americana types, *Prunus Americana.* The common wild plum of the north, and extending westward to the Rocky Mountains and southward to the Gulf and Texas. Admirably adapted to climates too severe for the domestica plums, as the plains and the upper Mississippi valley. VI. The Wild Goose or hortulana types, *Prunus hortulana.* A mongrel type of plums, comprising such kinds as Wild Goose, Wayland, Moreman, Miner and Golden Beauty. No doubt hybrids of the last and the next. VII. The Chickasaw types, *Prunus angustifolia* (or *P. Chicasa*): Native to the Southern states, and there cultivated (from southern Delaware southwards) in such varieties as Newman, Caddo Chief, and Lone Star. VIII. The Sand plum, *Prunus Watsoni.* Native to Kansas and Nebraska. A bush-like species, little known in cultivation. A hybrid of this and the Western Sand Cherry is the Utah Hybrid Cherry. IX. The Beach plum, *Prunus maritima.* Native to the coast from New Brunswick to Virginia. In cultivation represented by the unimportant Bassett's American; also as an ornamental plant. X. The Pacific coast plum, *Prunus subcordata.* Native to Oregon and California.

Sparingly known in cultivation, chiefly in the form known as the Sisson plum (var. *Kelloggii*).

In respect to varieties, it is difficult to make any classification of those of the domestica stock. Perhaps the best that could be done would be to make four loose groups, as follows: 1. Damsons, comprising very small firm plums of various colors, generally borne in clusters, the leaves mostly small. The run-wild plums of old roadsides and farmyards are mostly of the damson type. 2. The green gages, comprising various smallish, green or yellow-green plums of spherical form and mostly of high quality. Reine Claude is the commonest representative of this group in New York. There seems to be no specific Green Gage generally propagated in this country. The name has now come to represent a class of plums. 3. Large yellow plums, such as Coe's Golden Drop, Washington, and the like. 4. Large colored plums, including the various red, blue and purple varieties, like the blue prunes, Lombard, Bradshaw, Quackenboss, etc. In respect to hardiness of the different types of plums, it may be said that the Japanese and domestica varieties are about equally resistant to cold. The Americana types are very hardy.

The Plum Orchard.—Concerning the general question of plum growing, it may be said that the plum is emphatically a special fruit; that is, it is one which does not have a regular standing in the market as pears, apples or even peaches have, but is more or less dependent for its sale upon the general supply of other fruits. In other words, it is a fruit of secondary importance, so far as the market is concerned. This being the case, it will readily be seen that it is not a difficult matter to overplant for the plum market.

The plum thrives upon a variety of soils, but it generally does best when planted upon clay loam. It usually thrives best upon lands which are suited to pears, or upon the heavier lands which are adapted to apples. Yet there are many varieties which thrive well upon lands which are comparatively light and sometimes almost sandy.

The stocks upon which plums are grown are various. By far the greater number of the trees in the north are now grown upon the myrobalan stock, which is a species of rather slow-growing plum, native to southeastern Europe and southwestern Asia. This is the stock which is sometimes recommended in the older fruit books for the making of dwarf trees; but unless the top is kept well headed in, the trees generally make normal growth upon it. Trees grown upon this root are usually larger and finer at one or two years of age than those grown upon other plum stocks, and the probability is that they are nearly as useful from the grower's standpoint as any other. However, there are some varieties which overgrow the myrobalan, and the stock is very likely to sprout from the ground and thereby cause trouble. In the southern states the peach is largely used as a stock upon which to grow plums. It is undoubtedly a very excellent stock for sandy lands, and, in fact, is probably more preferable for such lands than the myrobalan itself. Some varieties—of which the Lombard and French Damson are examples—do not take well upon the peach. The Japanese plums are commonly worked upon the peach stock and they seem to make an excellent union with it and to give every promise of being hardy and durable. The Marianna stock is much recommended in the south.

Many of the varieties of plums are such slow and crooked growers in the nurseries that it is advisable to graft them or bud them upon some strong and straight stock. The Lombard is no doubt the best stock for this purpose which is now grown by nurserymen. The old Union Purple is one of the very best of stocks, but it is not grown much at the present time. All such varieties as Reine Claude, German Prune, Copper, etc., are probably best when top-worked upon some such stock.

Plum trees are usually planted when two years old from the bud, although some of the strong-growing kinds may be planted at a year old with the very best results. As a rule, plum trees are planted about as far apart as peaches are, that is, from 15 to 18 feet apart each way. Many growers prefer to plant them closer one way than the other and eventually to stop cultivation in one direction. If this system is used, they may be placed 18 or 20 feet apart one way, and from 10 to 12 feet the other way. The trees are pruned in essentially the same way that apple trees are, when planted. It is generally advisable to start tops as low as possible and yet allow of the working of the curculio catcher below them. This means that the limbs should start out from three or four feet above the ground. With the modern implements and methods of tillage, there is no inconvenience in working the land if tops are started as low as this.

The subsequent pruning of the plum tree has no special difficulties. About four or five main limbs are allowed to form the framework of the top, and in most varieties, especially those which are not very tall growers, the central trunk or leader may be allowed to remain. There is constant demand for information as to whether young trees should be headed in. There can be no positive answer to this question. If the trees are growing very vigorously, so that they become too tall and whip-like, it is best to head them in; but it must be remembered that this redundant growth commonly ceases and the tree begins to spread when the bearing time arrives. If trees are making too vigorous growth, the real corrective of the difficulty is to stop the growth by withholding fertilizers or cultivation rather than by heading in the tree. Vigorous heading in only makes the growth the stronger. All this is a very different matter from the customary heading in of old trees. Some growers prefer to let a plum tree take its natural open, spreading growth, whilst others desire to keep it sheared in to allow the trees to be planted closer together and to keep the fruit nearer the center of the tree. This is very largely a matter of personal preference and there are probably no very decided advantages in either system when it is carried out systematically and conscientiously. It should be said that the plum tree needs careful attention from year to year to keep the top in shape, to cut out and paint over all injured places and in other ways to protect the tree from accidents and from injuries of storm and insects.

In common with all fruits, the plum demands good tillage and liberal feeding if satisfactory results are to be obtained. The extended remarks upon the tilling and fertilizing of fruit lands apply with full emphasis to the plum. Well-tilled trees should begin to bear when three years set, and, at eight and ten years of age, the prolific varieties should be bearing three bushels of first quality fruit in every good year.

Varieties.—The most popular variety of the plum, and also one of the poorest, is the Lombard. Its redeeming merits are its great productiveness and the vigor and hardiness of the tree. The fruit is of only fair quality, it comes at a season when the market is full of plums and other fruits, it is very susceptible to the leaf-blight fungus and the fruit-rot, and its color is not of the best. The very fact that it is the commonest and cheapest plum would seem to indicate that it is not the best variety from which to make the greatest commercial success; yet there are many orchards of it which are very successful commercially. The best markets are likely to be found for the early and late plums, and for those which have very pronounced colors, especially those which are dark red or purple. Some of the dark yellows are also very excellent for market fruits. Fruits of nondescript colors, like those which border on the ill-defined reds, the browns and the lemon yellows, are usually not profitable. There is some exception to all this in the case of the Reine Claude, which is a yellowish-green plum; but its great merit as a culinary variety and its established reputation save it from the general condemnation of plums of that class. There is also an exception in the small Damson plums, which are highly esteemed in some markets for culinary purposes.

It would be impossible to give any list of varieties which would be adapted to any particular orchard. The question of varieties is very largely a personal one. Very much depends upon what ideal the grower has in his mind, and also upon his soil and location and the like. Amongst the plums which can be most confidently recommended for the latitude of New York are the following: Field, Bradshaw, Coe's Golden Drop, Hudson River Purple Egg. Italian Prune, Empire, Grand Duke, Arch Duke, Monarch, Gueii, Peter's Yellow Gage, Reine Claude and Copper. Amongst the Damsons, the French and the Farleigh are perhaps the best. The Japanese plums recommended are the Red June, Abundance, Burbank and Chase. So far as known, the domestica and Japanese plums are self-fertile, but it is always the safest course to plant varieties in alternate rows.—(Cornell E. S. B. 131.)

Marketing.—Plums are apt to overbear so that the fruit runs too small for the best market price. Some plums habitually set many times as much fruit as they should ripen. Even when such trees are heavily manured the trees are short-lived. The market is becoming more discriminating every year as to size and quality of fruit so that the man who has a few trees well cared for will realize a better price than one who raises more than he can take care of properly. Thinning is done as soon as possible after the June crop. This question of overbearing may be one for the plant-breeder who recognizes the need of originating varieties that bear enough but not too much. Overbearing is a serious fault as the question of labor in thinning becomes an important item.

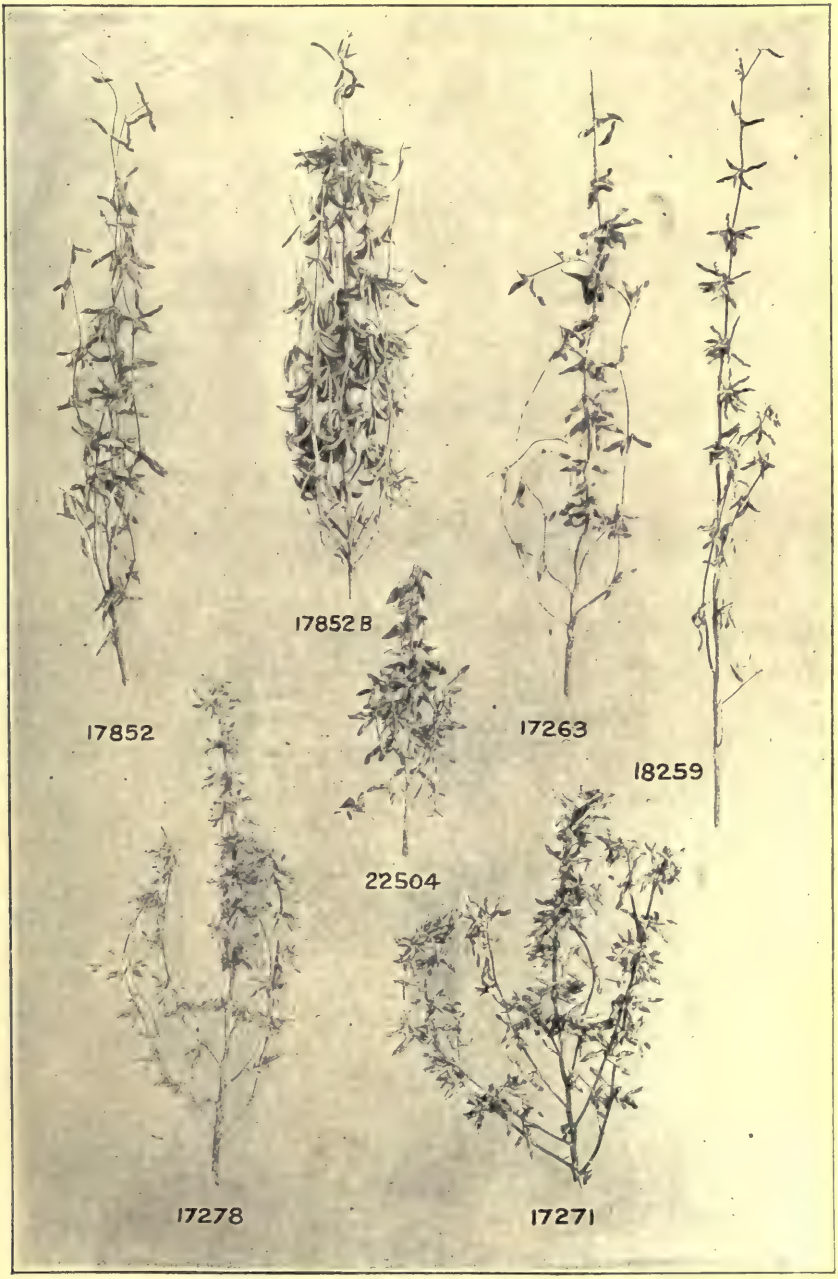
For market plums should be picked before they are fully ripe as when fully ripe they must be used immediately and cannot be shipped any distance. An overripe plum means that the process of decay has already begun. In local markets plums have been observed sent in berry boxes. This might do for the first early but the main crop can be sold in ten-pound grape baskets. Extra fancy fruits could be sold in the tin-edged splint baskets in which California plums are so generally shipped. Only for fancy fruit will such small baskets be profitable. The man who handles his plums as roughly as he would potatoes cannot expect to get a good price. The fruit should be picked by hand and not shaken off the trees. If the latter method is resorted to for plums to be used immediately for plum butter or preserves in general, a sheet should be spread under the tree before shaking. The half-bushel and bushel basket covered with red mosquito bar are used on plums sold by the bushel for preserving. In general, the lower the grade the larger and cheaper is the package used.—(S. Dak. E. S. B. 93.)

PRUNES.

The term "prune" may be applied to any plum that dries readily, but more particularly to plums containing over 12 per cent of sugar, as this is approximately the amount that a good dried plum should contain. Of all the American fruits preserved by the process of evaporation the prune certainly takes first rank. The process of evaporation has for its object primarily to drive off a sufficient amount of moisture to make the fruit keep in such a manner as to leave the fruit soft, pliable and palatable, and with as much of the original color and flavor as possible, and in case of the prune to leave the flesh of a transparent appearance; a clear yellow in the case of the French prune, and an amber in the case of the Italian. No prune which has not these characteristics has been properly cured.

The soil types known as sandy (clay and lime) are considered the best for the prune, though pomologists agree that the plum in general is not very particular about the soil in which it grows so long as it is neither too light and limy, nor too wet. In the West thousands of acres are devoted to the raising of prunes alone. The three classes grown commercially are: Italian, Petite (Prune of Agen), and Silver (Coe Golden Drop). Other varieties are classed with one of the three mentioned, according to size and color. Prunes which do not naturally fall into one or another of these classes are not readily salable.

Prune Kernels.—The pitting of prunes is not carried on to such an extent as is the case with peaches and apricots, this treatment being a relatively new feature. Attention is nevertheless directed to the large amounts of fixed oil and volatile oil which may be produced from these kernels, as well as from those of peaches and apricots,



Seven Varieties of Soy Beans After Hanging in a Dry Room For Six Months.
Dept. of Agr.

should they be utilized for this purpose.—(U. S. Pom. R. 1894; Ore. E. S. B. 61; U. S. Pom. B. 10; B. P. I. B. 133.)

CHERRY.

The cultivated kinds probably came from two species known botanically as *Prunus avium* and *Prunus cerasus,* but during the centuries that have elapsed while they have been under cultivation they have been crossed and recrossed until it is impossible to separate the varieties into their species. The cultivated sorts are divided for convenience into two classes: (*a*) Kinds having sweet juice, including what are known as Mazzard, Hearts, and Bazella cherries. These varieties are generally tall and erect-growing trees. (*b*) Kinds having sour or subacid juice, including what are known as Sour, Morello, and Early Richmond cherries. These trees are usually low headed, with spreading branches. *Prunus mahaleb* is a small, slender tree, bearing small, dark red, austere fruit, and is a native of southern Europe. It is used for stocks upon which cherries are propagated. The wild American cherries include *Prunus besseyii, Prunus demisa,* and a number of others. They are of little importance commercially, although where found in large quantities they are used locally.—(U. S. E. S. B. 178.)

Propagation.—The common method of propagating the cherry is by budding one year old seedlings. The two commercial stocks most commonly used in propagating the cherry are the Mahaleb and Mazzard. The Mahaleb (*Prunus Mahaleb*) is a native of southern Europe. The seedlings are grown there in large quantities and are imported in large numbers by our nurserymen. It is used exclusively for budding and is of no value for root grafting. It is hardier than the Mazzard, especially in a dry climate, although too tender for the severely cold sections. It is best adapted to the sour varieties of cherries. The Mazzard is a strong growing variety of the sweet-cherry (*Prunus Avium*), and is a native of eastern Europe and western Asia. It is used exclusively in the east and in the warmer sections of the west as a stock for the sweet varieties. It is not sufficiently hardy for the severely cold sections. This stock can be used for root grafting but this method is little practiced and is used almost entirely for budding purposes.

The cherry may be top grafted the same as the apple or the plum. It is very important that the work be performed very early in the spring before the sap begins to flow and while the scions are yet dormant. Unless the work is done at this time it is likely to result in failure. Any grower who may have trees that seem to be perfectly hardy in stock but tender in bud, can top graft with some hardy variety that will change the top of the tree in time to a hardy, productive sort. The Bessarabian, for example, is very tender in bud but hardy in stock, and may be valuable for top grafting. Many of the varieties that have been tested and found to be worthless could be changed to valuable varieties by top-grafting.—(Ia. E. S. B. 73.)

Soil.—Cherries will thrive on almost any well drained soil, but they show a preference to a rather light gravelly or sandy loam. In very rich, black soil, they tend to an overproduction of wood and produce but few fruit buds. In soils of medium fertility the following distances should be taken as the minimum that should be allowed in planting varieties belonging to the following groups, and it should be added that the mistake is more likely to be made of planting them too close rather than too far apart. Varieties belonging to the Montmorency group, 18 feet each way; Morello group, 16 feet each way; Brusseler Braune, 20 feet each way and Vladimir, 14 feet each way. On very rich soil these distances should be increased accordingly. The trees should be planted very deep, ten inches to one foot deeper than they stood in the nursery. Fruit buds of the cherry are often destroyed by spring frost and for that reason it is always advisable to choose the elevated site which is less liable to frost than a valley or low land.—(Ia. E. S. B. 73.)

Cultivation.—The cherry orchard should be kept cultivated. But at the same time nearly enough vegetables, root crops or small fruits may be grown to pay for the cultivation. Potatoes, beans, beets, carrots and squashes make ideal crops for young orchards. They are low growing, require hand cultivation, and do not impoverish the land. Strawberries, raspberries and blackberries are sometimes successfully grown in young orchards. They should never be allowed to grow less than four feet from a tree and as the trees grow and take the ground, they should be removed from the orchard altogether. Oats, wheat or field corn should never be grown in a cherry orchard under any consideration.

Pruning.—In shaping the young tree for planting the head should be made as low as possible on the tree and in order to get low headed trees it is necessary to plant young trees that have not been trimmed up in the nursery row and set them deep. The low heading of the tree protects the trunk from sun scald and it can be more effectively and cheaply done in this manner than in any other. Low heading also brings the fruit closer to the ground and makes it easier to gather which is an especially important point with the cherry where the harvesting of the fruit is such a large item.

Protecting from Birds.—Many things have been recommended to prevent the birds from getting the fruit. Some eastern growers have been successful in planting some of the earlier sweet varieties that are adapted to that section, thus allowing the birds to get their full share before the more important and late varieties ripen. The growers in the cold sections of the west cannot adopt this plan on account of the fact that the earlier sweet varieties cannot be grown there. In the large orchard there are enough cherries for the owner and the birds; but it is on the home place where only a few trees are raised to produce the home supply of fruit that the trees need protection from the birds and here the plan of covering the trees with netting will be found very satisfactory and efficient.—(Ia. E. S. B. 73.)

Study of Varieties.—Cultivated cherries are usually divided into two general classes, the sweet and the sour, and these have probably come from two European species, *Prunus Avium, Linn.,* producing the sweet cherries, and *Prunus Cerasus, Linn.,* producing the sour cherries. The former type is characterized by large, erect and tall-growing trees; fruit red, yellow or black, mostly heart-shaped or pointed and generally sweet. The groups known as Hearts, Bigarreaus, and Dukes are included in this type; and as representatives of it and the three groups respectively, may be mentioned the varieties Governor Wood and Black Tartarian, Windsor and Napoleon, May Duke and Reine Hortense. The sour cherries are readily recognized by a low, round headed, and spreading tree; fruit roundish and generally sour. The groups known as Morellos and Amerelles belong to the sour cherries; and as representatives of this type and the two groups respectively, may be mentioned the varieties English Morello and Louis Phillippe, Early Richmond and Montmorency. As a rule the sour cherries are the later in ripening and the hardier of the two types.—(N. Mex. E. S. B. 39.)

Commercial Possibilities.—The cherry is probably grown less for commercial purposes than any of our other orchard fruits, not because the profits of growing it are less but because the fruit ripens in midsummer and requires more work to harvest than any of the other fruits. The cherry is what might be called a home fruit. The tree is small growing and naturally ornamental and appropriate to plant in house yards and near buildings.

The demand for the fruit is staple and it is very seldom that a glut in the cherry market is heard of. It is a fruit that has been neglected by commercial fruit growers and deserves to be much more widely planted.—(Ia. E. S. B. 73.)

THE GRAPE.

The grape should be more frequently found growing on the farmer's premises. It is of easy culture and brings almost certain reward for the care and attention bestowed upon it. It is a mistaken notion that its culture requires special skill and knowledge beyond his abilities.—(F. B 156.)

There are about twenty species of wild grapes in America. Few of them, however have been fully tested under cultivation. The grapes commonly grown in this country east of the Rocky Mountains are of native origin, but in the Pacific Coast States a number of European varieties are grown in great perfection. Some points of interest in this connection are grouped under the following heads: (*a*) Several varieties of the European wine and table grapes (*Vitis vinifera*) do well in California and adjoining States but fail in the Eastern States. Among these are the Tokay, Sultana, and Muscat. (*b*) The best table grapes of the Eastern States have originated from the native Fox grape (*Vitis labrusca*). Of these the Concord is the most widely and generally grown. (*c*) Hybrids of the above-mentioned species exist in large numbers. It has been found that the presence of any considerable amount of the European wine grape in any variety usually causes a corresponding loss in hardiness. The Rogers hybrids are examples of this. (*d*) the *Vitis riparia* or the River Bank grape of the North crossed with the *Vitis labrusca* has furnished a few extremely hardy kinds, as the Janesville and Beta. These are a great improvement over the original River Bank variety. (*e*) In the South there are other species that have produced good merchantable varieties. Many of these appear to be better adapted to the warm climate of the Southern States than the kinds that have come from northern stock.—(U. S. E. S. B. 178.)

The location of the vine or the vineyard should be determined with reference to its convenience to the home and to the fitness of the soil. The preference should be given to warm, open soil, free from excess of moisture, and fairly fertile. A south or southeastern exposure will usually give greatest satisfaction. If wild vines of the same species occur in the vicinity they will be found to have planted themselves in the most congenial soil, and therefore afford a sure indication of the place to plant. This is specially true where the wild vines are succeeding well.

Drainage and Breaking Up the Soil.—The grape is a trailing shrub, capable under favorable conditions of making an enormous growth of wood and fruit. To enable it to do its best the soil must be prepared for a corresponding growth and development of its root system. Grape roots are not found deeply embedded in the soil, but they are numerous and slender, and wander to great distances in search of an abundant supply of plant food. If the soil is hard and compact it will be difficult for the roots to find the proper food supply to produce satisfactory crops of fruit. Thus the importance of thoroughly pulverizing the surface and subsoil is apparent. The thorough pulverizing of the soil in connection with tile underdraining is a well-known safeguard against the evil effects of excessive moisture as well as protection against excessive drouth.

The first work in preparing the site chosen for a vineyard, especially if it be on clay soil, will be its thorough underdrainage by tiling. The size of the tile to be used should be determined by the extent and area to be drained. Three-inch tiles will generally be found sufficiently large. They should be laid so as to afford an easy escape for the water by having an outlet in some near-by ravine or on a slope. They should be laid at least 3 feet below the surface of the ground and in parallel lines about 2 rods (33 feet) apart. This, if well done, will effectually free the soil from any surplus water that may have been held in suspension.

After thorough drainage the ground is ready for breaking. A strong team of two or three horses and a good breaking plow, with a second team and subsoil plow to follow in the same furrow, will be an effectual and labor-saving method of procedure. A subsoil plow should not throw the cold subsoil up to the surface, but simply loosen and allow it to remain, where it properly belongs, in the bottom of the furrow. If the site is to be prepared by hand by the use of a spade, the same rule should be observed; turn the lower spit or spade of earth at the bottom and keep the warm surface soil on top. If in preparing the soil as above directed a liberal supply of compost or well-rotted manure is worked into it, it will be improved.

Fertilizers for the Grape.—As fertilizers for the grape unleached hardwood ashes and well-composted barnyard manure will be found among the cheapest and best. These are recommended both on account of cheapness and general accessibility as well as for their constituent elements of plant food. They should be used liberally and should be well mixed with the soil in its preparation before planting; they may be used afterwards as top dressing to be worked into the surface in the process of cultivation. Leaves, soap suds, old leather scraps, and lawn rakings have also been found beneficial to the growing vines. Such coarse articles should be worked into the subsoil below the level to be affected by subsequent culture, where they will decay slowly and will not be pulled to the surface by the tools used in cultivating the vines.

Commercial fertilizers of various kinds and manufacture are now accessible to most farmers who may desire to use them, but as they are well adapted to use as surface dressing, and generally with special objects in view, they may be applied at any time after the vines are planted. A full discussion of commercial fertilizers here is unnecessary and impracticable. The Department of Agriculture and many of the State experiment stations have published bulletins on fertilizers that may be obtained gratuitously upon application.

Propagation of the Vine.—As a rule the farmer is advised to obtain the few vines he may wish to plant for family use from some reliable near-by nurseryman, who will be qualified and willing to help him in the selection of varieties suited to his locality, rather than to attempt to propagate them for himself. He should, however, know and understand the more simple methods of propagation, and then, if opportunity offers, he can put his knowledge into practical use by propagating them for himself. Most varieties of grapes are easily propagated by one or both of two simple methods that are in general practice, viz., by layering and by cuttings. All varieties of the grape may be propagated easily by layering. The process consists in bringing a branch of the growing vine into direct contact with the soil and holding it in that position until roots are thrown out at the point of contact, after whch the newly formed vine or plant may be cut loose and transplanted to any desired place where it is intended to grow. One growing season will be required for the root system to be sufficiently perfected for severing the new plant from the mother vine.

Layering should be done in early spring. Plants may be made from one cane or shoot of the previous years' growth of wood. This is accomplished by placing the cane, when the buds have fairly started, in a shallow trench about 3 inches deep. After the shoots have grown a few inches a little earth should be drawn into the trench filling about the vine and the base of these growing shoots. In a few days a little more earth is to be worked in and so on till the trench is full. Meantime the shoots should be tied in an upright position to small stakes, and the ground kept well cultivated during the growing season. The following spring the buried cane or underground stem with its rooted plant at each node or joint, should be taken up and the plants separated by cutting them apart. Then each young plant will be ready for its permanent place in the vineyard.

Propagating by Cuttings.—Cuttings for propagation should usually be prepared in the fall. This will be a measure of safety against possible injury from severe winter weather that may follow, though if the winter proves to be mild, most hardy varieties would go through without injury, in which case they would still grow if cut fresh from the vine in the spring at the time for planting them out. Cuttings should be made about 1 foot in length or long enough to include three or more joints. They should always be made from a shoot of the last year's wood, called a cane.

The first cut, beginning at the base of the cane, should be made about half an inch below the lower eye or bud, then draw the cane forward to the desired length and cut off again below the bud in the same manner and so proceed until all the cane is divided into cuttings. The lower or butt end of each cutting will be thus recognized by its short and uniform length below the bud, while the upper end will have a longer stem or spur extending above the upper bud. This fact, if remembered, will always enable the planter to determine which end of the cutting is the lower end, the one to be inserted in the ground.

If the cuttings are made in the fall, as they usually should be, they may be tied in bunches of convenient sizes and buried in a dry place in the garden by covering them completely with fresh, clean garden soil, until time for planting in the following spring. Great care should be taken not to place them where they will be covered by stagnant water at any time during the winter.

As soon as the soil is in proper condition to work in the spring, a bed or nursery row should be well prepared and the cuttings taken from their winter quarters and planted in a V-shaped trench which is made ready for them. When they are all placed in the open furrow, by leaning them against the almost perpendicular side at regular intervals of about 4 inches apart, the soil should be drawn in from the opposite side and, when the trench is partially filled, made compact about the base of the cuttings by a gentle pressure of the foot, after which the trench should be filled to the level. They should be so placed as to bring the upper bud of each cutting just even with the surface of the ground. During the spring and summer following, the ground must be well cultivated, allowing no weeds nor grass to grow among the young plants. Many, but not all, of the cuttings of most hardy varieties thus treated will grow and form good plants for the vineyard at the end of the first year. They are seldom so good for transplanting after they have stood the second year in the nursery.

Preparing the Young Vine for Transplanting.—If the farmer has grown his own vines the first step in transplanting them to their permanent places will be to dig them from the nursery or plant bed where they have grown. And here great care must be observed or the roots will be badly mutilated. It has already been said that grape roots are long, slender, and numerous and that they naturally spread near the surface of the ground. If the spade is inserted near the vine the roots will be cut short and fatal consequences will probably follow the operation of transplanting. Set the spade not nearer than a foot from the young plant and work under it from this point of beginning; at the same time gently lift or pull the vine but not hard enough to strain or break its roots. If, however, there are roots that are broken or mutilated in the operation of digging, as is likely to be the case, they should be cut smoothly at their ends, which will greatly encourage the formation of new roots in place of those broken or cut away. This same care should be given plants that are purchased from the nurseryman before planting them out. Cut back the previous year's growth of wood to a spur of two buds. If the young vine has been neglected in the nursery and allowed to form several shoots they should all be cut back in the same manner.

Care should be taken in these operations to guard the roots of the vine from all avoidable exposure to sun and wind. When a plant is dug and its roots and top pruned as above directed, and it is made ready for planting, in case it is impossible to plant it at once, its roots should be immediately covered with fresh earth or otherwise protected until it is wanted for planting.

Distances Between the Vines.—Farmers almost invariably use horse cultivators. It will be well, therefore, to plant the vines, when more than a dozen in number, with this fact in view. It is inferred that the vineyard will be subordinate to the general farming operations; hence the vines should be planted in long lines or rows for convenience in using the horse and cultivator in their culture. The proper width of rows will be 7 or 8 feet, about double the space allotted to several ordinary farm crops. Then the cultivator may pass, if necessary, directly from the adjacent field crops and through the vineyard rows. This will establish the distance apart of the rows of vines, and the average distance between vines in the rows may be safely fixed at 8 feet, though this will depend somewhat upon the system of training intended and the varieties to be planted. Strong-growing varieties like Concord or Niagara will require a little more space, while feeble-growing ones, such as the Delaware, may do well with less.

Time and Method of Planting.—It will be well for the vines if a cloudy, damp day (not wet) in spring or fall be chosen for their planting, as the roots will be less injured by exposure to such an atmosphere as would then prevail. The digging of the holes is of minor importance, as it is inferred that the soil of the vineyard site has been thoroughly prepared before the time of planting and the holes will need to be made only large enough to receive the roots of the vine without cramping them. The bottom of the hole may be made a little higher in the center so that the roots of the vine, when it is placed on this highest point, will be a little deeper at their outer end. They should be evenly distributed so they will start out in every direction from the vine, their common center, as they were originally formed. Fill in about the roots with well-pulverized soil and the work of planting is accomplished. The plants should be set a little deeper than they stood before they were taken up for transplanting.

Supports and Training.—The support for the young vine at first may be temporary, a mere stake or pole sufficiently strong to bear its weight and tall enough to train it in an upright position for one or two seasons. During this time it should be trained as a single shoot, from which all lateral or side branches are pinched off as soon as they are formed. These lateral or side branches will start at a point above each leaf and will be very easily broken off if attended to early.

At the end of the first year's growth of the young vine, treated as above directed, it may be expected to resemble an upright stem. A well-cultivated grape-vine of the Concord or some equally strong-growing variety should then be from 5 to 10 feet in length. Its treatment the following or second year will depend somewhat upon the training intended. In any event it should be cut back in the fall or winter of the first year to within about 2 feet of the ground.

Only the two upper buds should be allowed to grow for the second season, and they should be treated as the single shoot of the previous year was; that is, by training them to single shoots. If the vine, now in its third year's growth from layer or cutting, is a strong one it may be allowed to bear a cluster of fruit on each of the two shoots of wood of this year's growth. In the fall or early winter each of these two shoots (now called canes) should be cut back to about 2 feet in length. The vine will then have its stem and two branches or canes cut back to an even length, as they are intended for the permanent horizontal arms of the vine that is to be.

Permanent Supports.—The vine has now passed its second year in its permanent location and is ready for a more enduring support. This may be a stake, a building, or a trellis. The stake is now almost obsolete, having been superseded by the trellis, made cheaper and really better than the stake through the use of wire in its construction.

Training on Buildings.—Many farm buildings, and even the dwelling itself in some instances, may be utilized in supporting a vine or vines, and in not a few cases would be made more beautiful. If the vines are to be trained on the walls of buildings, they should be planted in a well-prepared border or bed, a few inches from the foundation, and the eaves should have gutters to carry the excess of water away from their roots. The vines should be securely attached to the wall to prevent them from giving way under the weight of fruit. A strip of woven wire may be attached to the wall and the vines tied or fastened to it. In this way the building will not be damaged by fastening the vines directly to the wall. With buildings of little value the vines may be made fast by tacking strips of old leather or even cloth over the branches and against the walls at convenient distances apart. A wall, because of its warmth and dryness, is an excellent place to grow fine grapes, and if the vine so planted is properly trained and cared for it will become an object of beauty and a joy to the farmer's household.

The Trellis.—The trellis, the most simple and now the almost universal form of support for the vine, especially in northern sections of the United States, is built of posts and wires. It may be plainly and cheaply made or it may be elaborate and expensive. In order to build a good trellis the posts must be made of durable timber, well set in the ground, and firmly braced to prevent sagging of the wires under the weight of the vines and fruit. The end posts must be securely braced. The wire used in constructing a trellis may be of any size from No. 12 to No. 8. Though the latter will cost a trifle more, it will be much the best in the long run. From three to five strands of wire will be sufficient for a good trellis.

The Arbor.—The arbor, which is really a double trellis, connected overhead by a wooden frame, covered with wire netting or wires drawn across the top, may be desirable near the house or in the garden. The vines are trained to an arbor as they should be to any ordinary trellis, except that they are allowed to meet overhead. In this way a shady bower is produced which is very agreeable in hot, sunny weather, while it affords a wider expanse of vine and foliage for the support and maturing of the fruit.

The Canopy Trellis.—A single line of posts are set as for an ordinary trellis. Pieces of scantling about 2½ feet in length are spiked horizontally across the top at right angles to the line of the trellis. On the upper side of these cross or horizontal pieces three wires are strung, one at each end and the third in the middle. The vine is trained to the center wire in a single stem, at which level its top or arms are formed. The shoots or bearing wood of the vine droop or hang over the other wires. In some parts of the country, especially in large portions of the South, this form of trellis is very popular with vineyardists. They claim it protects and shades the fruit from the injurious effects of the hot sun.

Training the Vine:—Referring again to the young vine at the end of its second year in the vineyard, with its two branches or canes of that year's growth cut back to a uniform length of about 2 feet, it will be seen that its stem or first year's growth of wood was cut back to about 2 feet, and at this height its two branches of second year's growth were started. The trellis is now built with its lower wire at the same height as the stem of the vine, or about 2 feet from the ground. The branches of the vine grown the second year and intended for its permanent arms are turned down and fastened horizontally to the first wire of the trellis in opposite directions.

The third year the shoots that spring from these horizontal arms at each node or joint are to be trained upward and made fast to the other wires of the trellis, which are about 1 foot above each other. Each of these upright shoots may be allowed to produce one or two bunches of grapes this year, and there should be about three shoots from each arm of the vine, or six in all.

If the vine is attached to a building or wall the same plan of training will be followed in developing its permanent parts. The horizontal arms with their upright shoots can be formed on the wall or building just as they should be on the trellis or arbor.

Pruning.—In adapting the vine to wants and requirements radical changes in its habits are necessarily forced upon it. In a state of nature it will mount to the top of the tallest object within its reach, in order to secure to itself the light and sunshine that it requires to perfect its growth of wood and fruit, and as its fruit is always borne on the current year's shoots, the grapes would be far out of reach when harvest time came. In order, therefore, to restrain its natural habit, and to adapt it to domestic requirements, the vine must be pruned into a shape better adapted to conditions.

In the autumn of the third year the vine is fully established, with its permanent upright stem and its two horizontal arms, each with its three or four shoots or canes trained upward to the top wire of the trellis, each of which has borne one or two bunches of grapes. When autumn frosts suspend vegetation the vine is ready for its annual pruning before entering upon its winter's rest and preparatory to bearing a full crop in its fourth year.

Renewal Pruning.—Each alternate upright cane on the horizontal arms should be cut down to a short spur at a point near the arm, and the others cut off even with the top wire of the trellis.

The following spring a single shoot is allowed to grow from each of the spurs on the horizontal arms to be trained vertically to the wires above, and the eyes (from six to ten) on the canes that are left from the previous pruning will send out the fruit-bearing shoots for the current year. These fruit-bearing shoots are to be trained on the wires of the trellis, and may be allowed to bear one or two bunches of fruit each. If there are six eyes or buds on each upright cane, and there are three or four of these, the number of bunches of fruit to each vine may be estimated at from twenty-five to forty.

When the grapes have been harvested and the season (late fall or early winter) has again come for the annual pruning, the canes that have borne fruit are to be cut down to short spurs, a few inches from the horizontal arms, and the shoots that have grown from the spurs of the preceding year are to be retained for fruiting the succeeding season. In this way new wood, that is absolutely necessary to the production of fruit, is always provided for each succeeding year, and that, too, within the limited space allotted to each vine.

When to Prune.—An annual pruning should be given all grapevines at some time during the period of rest, between the late fall frosts and the early movement of sap the following spring, but never prune when the wood is actually frozen. Good authorities agree upon this, though they may differ as to the exact time that it is best to prune. In the latitude of central Indiana it has been found best, for several good reasons, to practice fall pruning. If done then, it is out of the way of the rush of spring work. Also the weather is usually pleasant, and the work may be done with less personal exposure to the operator. If pruned in the fall, there can be no danger from "bleeding," a term used to designate the waste of sap from the newly made wounds which follows late spring pruning. If pruned in the fall and the prunings are immediately burned, many disease germs and insects will be destroyed that would otherwise survive the winter, and that would prey upon the vines the following season. Furthermore, fall-pruned vines can be more easily protected from the severity of the ensuing winter.

Summer Pruning.—Summer pruning is a mere training of the growth of the vine as it develops, and should be performed at a time when the shoots are young and tender, so that superfluous buds may be readily pinched or broken off with the thumb and fingers. It begins with the beginning of the season's growth, usually in May in the North.

The vine developed as directed has its horizontal arms trained in opposite directions on the first wire of the trellis. On these arms are fruit-bearing canes and renewal spurs. On the fruit-bearing canes, trained upward from the arm to the top of the trellis, there will be from three to six eyes, according to the height of the trellis and the length of the joints of each cane. From each eye only one shoot, and that the most vigorous, is allowed to grow, but these shoots, one from each eye, should be carefully guarded. They are very tender and may be broken off if not supported until sufficiently hardened or until they have clasped the wires with their tendrils. A high wind or even a small bird alighting on it may break off one of these tender shoots, and in that case the fruit prospect at that point is gone for the year. These fruit-bearing shoots should be trained on the wires of the trellis.

The fruit clusters will be borne on these shoots at distances ranging from 6 to 15 inches from their base. There will be one, two, sometimes three, or even four clusters on each shoot, the numbers varying according to the habits of the variety, etc. The shoot should be pinched back at a point about 10 inches beyond the last bunch of fruit. It will then incline to throw out laterals or side branches. They, too, should be pinched off at the second or third leaf from their base. This will be all the summer pruning the bearing wood will require.

Again, at the beginning of the season a single bud is allowed to start from the renewal spur made by cutting away the cane that had borne fruit the year before, and occurring on the horizontal arms alternating with the fruit-bearing canes of the current year. This should be trained up to the top of the trellis, and all the side shoots or laterals that are thrown out from it should be broken off. This shoot is for the bearing wood the succeeding year, after the wood that has borne fruit this year is cut away to form the renewal spur.

The Best Grapes for Home Planting.—The principles that form the basis of vineyard management are general and simple. With the selection of varieties, however, it is very different. Their behavior and requirements are varied according to climate, soil, exposure, etc., so that it would be the sheerest presumption, without personal and practical experience, to offer a list for the planter in any given section. A few varieties, however, can be grown successfully in many parts of the North. Among these none have yet surpassed the well-known Concord and its seedlings the Worden and the Moore, syn. *Moore's Early,* both black, and the Niagara, a white or green grape. It is worthy of note that a summary of answers to inquiries sent out within recent years to hundreds of practical fruit growers from Maine to California, shows that, with one exception (that being the Delaware), the Concord and its three seedlings, named above, received the widest range of recommendations given any hardy grapes.

The Delaware is of the highest quality of fruit, indeed, the standard of excellence among our native grapes, yet it is always to be understood that it is recommended with qualifications. In a very few localities, with special care and skill in its culture, it is a leading market, as well as home variety, but the inexperienced grower is not likely to succeed with it. Therefore it can not be recommended to him for general planting.

The Catawba is one of the oldest and best known of native varieties. It is a very late grape and of recent years has succeeded well in only a few favored localities. Where it still succeeds nothing better can be planted for late use. Other varieties which are worth mentioning in this connection are Brighton, Cottage, Diamond, Elvira, Ives, Janesville, Moyer, Pocklington, Salem, Winchell, syn. *Green Mountain,* and Woodruff. But these are recommended only for certain localities where they have been tried, or to persons who are willing to risk a failure for the sake of the chance of getting something especially good and more or less rare.

Sacking Grapes.—Grapes have a number of enemies; some are of fungous origin, others are insects, and still others are birds. They may be effectually protected and shielded from many enemies by the proper use of sacks. The sacks recommended for use are made of tough paper, and may be purchased cheaply by the thousand, if necessary, from dealers in supplies of this character. They are such as grocers use for putting up small packages for their customers. Those holding about 1 quart, known as 2-pound sacks, are a good size for most varieties of the grape. A few varieties having very large clusters may require larger sacks.

A single sack is to be placed over each cluster and made fast by the use of a pin, small wire, or tie of some kind and allowed to remain there until the fruit is ripe and ready for use. To be thoroughly effectual as a safeguard against the attacks of disease and insects the sack must be placed over the cluster soon after the blooming season is past; if possible, before the young grapes are larger than bird shot. A little delay will often give the germs of disease and depredating insects an opportunity to plant themselves on or in the newly formed fruit, when the sacks will fail to perform the good service expected of them.

The sacks are easily and quite rapidly applied, especially where the vines are properly trained, as the fruit clusters will then be in easy reach of the operator and will be much fewer in numbers and of better size than if the vines were neglected. The expense of sacks and labor is trifling, and the good results are beyond question. They may be summarized as follows: Sacks protect grapes from rot and mildew; from various insects, including bees, wasps, hornets, and flies of all kinds, and from the sting of the grape moth and curculio that produces the larva or worm that is so often found within the berry itself, and they protect them from the attacks of several kinds of birds that break the skin of grapes and invite further injury by bees and insects and from chickens. Grapes that have been sacked are always clean and free from dust and smoke, and being sound may be allowed to remain for use much longer on the vine than those not sacked. Indeed, they may remain on the vine until they are in danger of being frozen, and if then cut when dry and laid away in a cool, well-ventilated room, with the sacks on, they may be kept for use for a long time after grapes that were not sacked are gone.

The operator—perhaps the farmer's wife or daughter—equipped with sacks and pins or wires, slips the open mouth of a sack over the newly formed cluster of grapes and folding it down about the stem pins it in place or makes it fast by passing a very small piece of pliable wire around the neck of the sack and the work is done. The pins can be of the cheapest make, or if wire is used it should be cut beforehand into lengths of about 4 inches. The mouth of the sack must be carefully folded about the stem of the bunch, or otherwise it may admit insects or disease germs or even rain water that will sometimes fail to find its way out through the sack, and would thus spoil the fruit. A little practice will soon render the operator expert in affixing the sacks.—(F. B. 156.)

GATHERING, PACKING AND MARKETING.

For home use or for making wine, grapes should not be picked until they are fully ripe. Many varieties become highly colored some days, or even weeks, before they are fully matured; but they are not really ripe and in the best condition for use until the stem of the bunch begins to shrivel or soften so that it can be easily bent. Even for market, the fruit should not be gathered until very nearly matured, as it ripens but little after being removed from the vine. The unripe fruit may soften somewhat on its way to market, but does not become sweeter or better flavored, and will retain the excess of acid which disappears when the grapes are ripened on the vines.

Gathering grapes for market should be done only in fair weather when the vines and fruit are not wet with either dew or rain. The stems should be cut with a knife or scissors and the bunches should be laid in shallow wooden trays or baskets for carrying to the packing shed. Baskets holding 5, 8, or 10 pounds, with covers fastened on by wire hooks, are the best packages in which to ship, as they are inexpensive, easily handled in transportation, and convenient and tempting to purchasers. The fruit should be allowed to lie a few hours so that the stems will become slightly wilted; and all diseased, unripe, or bruised berries should be removed before packing begins. The bunches should be placed in the baskets with the stems downward, and packed snugly, the smaller bunches being used to fill the spaces between the larger ones. The top of the fruit should be about half an inch above the top of the basket and should be even and level. The baskets should be so full that some pressure will be needed to bring the cover down into place, though the pressure should not be so great as to crush the grapes or break them from the stems. A basket which is not packed closely will never carry the fruit in good condition; and, as the fruit is sold by weight, close packing is economical. The name of the variety, as well as the name and address of the grower, should be stenciled on the tops of the covers before they are put in place. Mixed or inferior fruit will seldom pay for shipping and will never add to the good reputation of the grower.

Nearly all grapes which ripen while the weather is still warm, are difficult to keep any great length of time without placing them in cold storage, which is expensive. They can be kept a short time by wrapping each bunch in paper and putting them in a cool place. Still better results will be secured by placing a layer of cotton batting in the bottom of a box, then a layer of fruit covered by another layer of batting. Not more than two layers of fruit should be placed in a box, and the upper layer should have a thick covering of cotton. Neither of these methods will be found profitable for market purposes, but will often be desirable when a little fruit is to be kept for some special purpose. There is considerable difference in the keeping qualities of different varieties, and, in general, the late-ripening sorts will keep longer after being gathered than will those which ripen early in the season.—(F. B. 118.)

SOME USES OF THE GRAPEVINE AND ITS FRUIT.

Perhaps no plant and its products are used in so many ways and for so many purposes as the grapevine and its fruit. The leaves may be applied to medicinal or surgical uses. For cuts and fresh wounds they are esteemed a sovereign remedy. Decoctions of the juice of the leaves may be used in poultices. An agreeable tea may be made from the leaves, which is said to greatly strengthen the nerves. The leaves are also excellent forage. The "tears" of the vine may be used medicinally. This is a limpid exudation of the sap at the time the plant begins budding, and is found on the vine where the slightest wound occurs to the plant. The liquid is collected by cutting off the ends of the canes, bending them down and sticking the ends into the neck of a bottle, which will be filled in a few days. The wood and branches have been used in the manufacture of baskets, furniture, rustic work, bark for tying material, etc., and when burned furnish potash and salts.

The grapevine responds most generously to care and attention. Thus, we find certain forms of it in the natural state aspiring to overtop the mightiest monarchs of the forest and single plants overspreading areas hundreds of feet in circumference, while other forms are grown under cultivation as mere bushes, 2 or 3 feet in height, yet yielding crops ranging from 1 1-3 tons to as much as 22 tons of the finest fruit to the acre. A single vine at Carpinteria, Cal., supposed to be the largest in the world, has produced in one season more than ten tons of fruit.

We enjoy the grape in the fresh state, or, when dried, in the form of raisins or "currants"; the unfermented juice, and wine are important items in household economy and medicine, while from the grape many other products and by-products are made. Aside from their economic value, vines are often cultivated for purely ornamental purposes, owing to their beautiful foliage and the rich coloration they assume, the shade they afford and their hardihood and longevity.—(Y. B. 1904.)

The grape is also the poor man's fruit, especially one who has only a house lot of the smallest possible dimensions. He can plant vines beside his cottage and their roots will extend and profitably occupy every inch of ground underneath it, and from that small space produce all the fruit his family can consume, while the vines afford shade and protection and add beauty to his little home, occupying no space, either above or below the ground, to interfere with other interests, and producing more fruit in less time and with less labor and attention than anything that was ever planted.—(Y. B. 1904.)

THE RASPBERRY.

Classes.—(*a*) The European raspberry (*Rubus ideus*). Varieties of this class were for many years the only kinds grown in this country. They proved, however, to be poorly adapted to our conditions, although in a few localities—as, for instance, near the Hudson River—they were a success. The Herstine, Hudson River, Red Antwerp, and Superlative are representatives of this class. (*b*) The American raspberries are the foundation of commercial raspberry growing in the United States. They embrace the red raspberry (*Rubus strigosa*) and the black-cap varieties (*Rubus occidentalis*). The Cuthbert, King, and Turner are of the red, and the Gregg, Older, and Ohio of the black-cap varieties. (*c*) Hybrids of the red and black caps are common. They were once regarded as a separate species and were name *Rubus neglectus.* Examples are the Columbian, Schaeffer, and Philadelphia. All raspberries in cultivation are divided into two classes: (1) Those that increase by tip layers, and (2) those that propagate by suckers. This is not a strictly botanical classification, but has been adopted for convenience.

Propagation.—The methods of propagation vary greatly with the different species. All may be grown from seed but do not come "true." In practice the following methods are commonly used: (*a*) The red raspberry may be grown from suckers. (*b*) Root cuttings are also used for propagating the red raspberry and some of its hybrids. (*c*) Tip layers are used for the black-cap varieties and its hybrids. (*d*) All kinds may be propagated by divisions of the stocks.

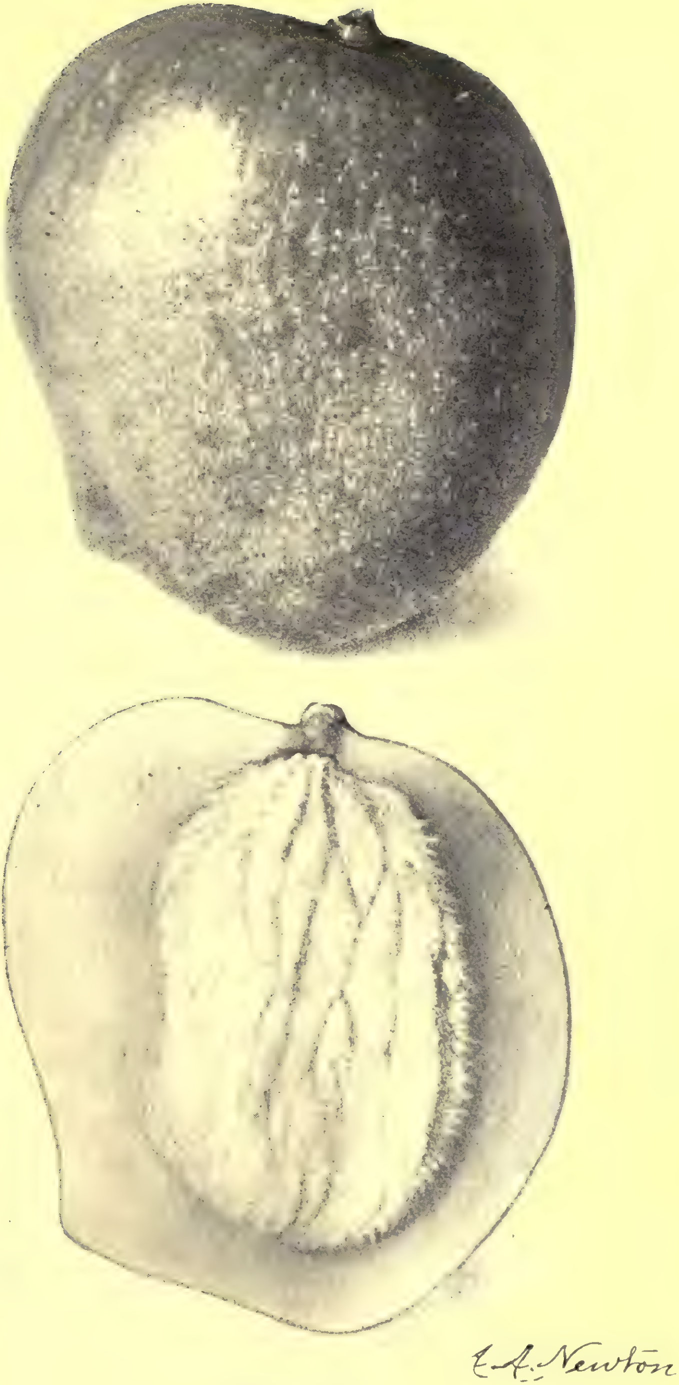
Soil and Location.—A cool location and a retentive soil are best for the raspberry. It is very liable to injury from hot sunny weather and drying winds, hence northern are better than southern slopes, and eastern better than western. The red varieties are better than the black for the South, while in dry northern sections the black caps succeed better than the red. Protection from drying winds is desirable, and it is frequently necessary to use wind-breaks for this purpose.

Planting and Training.—(*a*) Varieties selected for planting should be such as are adapted to the location and to the special purpose for which they are grown. Much depends upon the judgment of the grower in selecting a variety suited to his conditions and in buying strong, healthy sets for planting. (*b*) Plant about 4 by 7 feet apart. This, however, depends upon the kind of raspberries grown. (*c*) Red raspberries may be planted either in the autumn or spring. If black-cap varieties are set in the autumn, the work must be done with great care and the plants be protected with mulch in the winter. As a rule they should only be planted in the spring. (*d*) Suckering raspberries should be planted a little deeper than they grew. Cap sorts should be planted at the same depth that they grew. (*e*) In growing extensively trellises are seldom used, but in small gardens they are often advantageous. (*f*) The canes grow one year, and fruit the next. The old canes should be cut out and burned as soon as they are done fruiting. A hooked knife is generally used for this purpose. (*g*) When growth starts in the spring, all but four or five young canes of each plant should be cut out. If more are left they often become top crowded. The extent to which the thinning of the canes should be carried depends largely upon the kinds grown. (*h*) Spring pruning consists in shortening the lateral branches from one-third to one-half of their growth. Much more severe pruning is needed in the case of black caps than with red raspberries. (*i*) Summer pruning consists in pinching off the new growth when the canes are about 2 feet high. When the canes are covered in winter, this pinching should be done but once; where they are not covered the pinching off should be repeated to make the plants stocky. For summer pruning, sheep shears or a sharp knife is best.

Cultivation—(*a*) Hoed crops may be used the first year between the plants to advantage. (*b*) The cultivation should be shallow and continuous throughout the season. (*c*) Mulching is sometimes practiced, but it is seldom that good mulching material is sufficiently abundant to make its use practicable upon a large scale. A satisfactory method is to cultivate until the fruit commences to ripen and then mulch for 2 feet around the bushes, leaving the remaining 3 feet to continue to be cultivated. After picking remove all old canes and cultivate. (*d*) The tools used in cultivating raspberries are much the same as those in general use in gardens, and consist of the one-horse plow, the garden cultivator, and the hoe. An attachment for cutting suckers is sometimes put on the cultivator.

Fertilizers.—Stable manure is generally most desired for raspberries. If commercial fertilizers are used ground bone and nitrate of potash are as good as anything, and may be applied at the rate of 300 pounds of ground bone and 100 pounds of nitrate of potash per acre.

Winter Protection.—(*a*) In severe locations the canes must be laid on the ground and be protected in winter. In such places they should be pinched back but once for, if pinched frequently, the canes become too strong to lay down. Some of the best raspberry growers do not pinch back at all if they intend to lav the canes on the ground in winter. (*b*) A machine has been originated in Minnesota that covers raspberries and blackberries successfully, requiring four horses to operate it. It is there used on a large scale. (*c*) The proper time to raise covered canes in the spring will depend upon circumstances. They need not be uncovered until late, and may thus be held back



Peters Mango.

to escape injury from late frosts. (*d*) In laying raspberries it is important that the work be done before the severe frosts of autumn. The bending should be in the roots and as little as possible in the stems. (*e*) Trellises for raspberries are often used to advantage in gardens and in locations much exposed to the wind. For use on a large scale the best form is two wires stretched one on each side of the row and fastened to posts at each end and then tied together at intervals with twine. The wires should be about 2 feet from the ground. Such a trellis allows the plants to sway in the wind, and at the same time prevents them from breaking and keeps them out of the way of the cultivator.

The Fruit.—The fruit is red or yellow in color in the red raspberry class, and black, yellow, and purple in the cap class. The varieties vary in fruitfulness, vigor, size, and color of fruit.

The purple varieties do not sell well in most markets, and are therefore grown chiefly for home use.

Picking and Marketing.—Do not pick when the fruit is wet, and be particular to pick clean. Store in a cool shady place, and transport in a good spring wagon. Red raspberries are generally marketed in pint boxes, and black caps in quart boxes. In the West only the gift package is used, but in the Eastern States the return package is the custom. The selecting of the kind of package best to be used should receive most careful consideration by the grower.

THE BLACKBERRY.

Cultivated blackberries are grouped under five heads, as follows: (*a*) The high bush of the clearings and fence rows of the Northern States, with long clusters, as those of the Ancient Briton. (*b*) The type with lower growth and short clusters, as those of the Snyder. Both of these groups are probably forms of the *Rubus villosus.* (*c*) Trailing dewberries, as the Lucretia and Austin, known botanically as *Rubus canadensis.* (*d*) Forms that are intermediate between these species are probably hybrids of the two species just referred to. The Wilson and Rathburn are of this class. (*e*) The cut-leaved or evergreen blackberry (*Rubus laciniatus*), which is probably a form of the European blackberry (*Rubus fruticosus*). This variety is cultivated on the Pacific Coast, where it remains green all winter and is very prolific.

Propagation.—(*a*) The high bush blackberry is propagated by suckers and root cuttings. (*b*) The dewberry is propagated by layers.

Soils.—(*a*) The best soil for the high bush blackberry is a heavy clay loam, but it grows well on a wide range of soils. (b) The dewberry is best adapted to a warm sandy or gravelly soil, but even under best conditions is not nearly as reliable a bearer as the blackberry.

Planting, Cultivation, and Pruning.—(*a*) Plant and cultivate the same as for the suckering raspberry. (*b*) It is important to pinch the high bush blackberry canes at least once when 2 feet high, as this encourages the low setting of the fruit buds. (*c*) Spring pruning should not be done until the canes are in flower and the amount and location of bloom are seen. As a rule about one-half of the bloom should be cut off in the pruning. (*d*) It is desirable to have a trellis for blackberries and dewberries.—(U. S. E. S. B. 178.)

Conclusion.—Why the farmer necessitates his family dragging through dew-laden and tangled bramble patches, or else resorts to buying second grade and trashy fruit from the "professional berry picker," rather than grow high class fruit of improved quality, and which he knows to be entirely wholesome as food, is difficult to understand. A supply of berries for any family of ordinary size can be grown on a few bushes in the garden and with very little expense. These plants will need attention, however, just the same as any other crop; fine, luscious berries can not be grown without some care at the proper time.—(Va. E. S. B. 147.)

CURRANT AND GOOSEBERRY.

Origin.—(*a*) The red currant has descended from *Ribes rubrum* of Europe and America. Examples are Red Dutch and White Grape. (*b*) The black garden currant is the *Ribes nigrum* of Europe. Examples are Black Naples and Lee Prolific. (*c*) The Crandall is the *Ribes aureum* of western America which is practically the only form of this variety, but it varies greatly when grown from seed. (*d*) The American gooseberry has come from the *Ribes oxyacanthoides* of America. Examples are the Houghton and Downing. (*e*) The European gooseberry is *Ribes grossularia.* Examples are the Industry and Triumph. They are not much grown in America, as they are subject to mildew.

Propagation.—(*a*) Currants are grown from hardwood cuttings. Nearly all kinds may be propagated in this way, but some varieties do best from layers. Cuttings should be made in the early autumn and if planted out at once will be rooted by winter. (*b*) The American gooseberries seldom do well from cuttings and are consequently chiefly grown by layering the branches in the summer and autumn, then separating them and planting out like cuttings for one season. (*c*) Occasionally currants and gooseberries are grown by grafting to make what are called tree gooseberries and currants. Tree currants are also grown by pruning off all laterals. (*d*) New varieties are grown from seed. (*e*) Currants and gooseberries may also be grown from suckers.

Soil and Location.—Currants and gooseberries do well on any soil adapted to agricultural crops, but prefer a cool location and a retentive soil. They do not prosper in hot climates.

Plants and Planting.—(*a*) Thrifty one-year-old plants from cuttings or layers are best for starting new plantations. (*b*) They may be planted out in autumn or spring, and should be set deeper than they grew in the nursery. (*c*) On inferior land currants and gooseberries of the weaker-growing varieties may be planted as near as 4 by 4 feet, and some sorts may also be planted as close on rich soil. The strong-growing kinds, such as the Red Dutch and White Grape currants and the Downing gooseberry, should always be planted 5 by 5 feet, and often 6 by 6 is not too far. (*d*) Some hoed crop may be grown between the plants without disadvantage the first year.

Cultivation.—The surface soil should be well stirred and heavily manured. Mulching may be practiced with these fruits to better advantage than with any other.

Pruning.—(*a*) Pruning is done to renew the old and weak wood and to improve the size of the fruit. (*b*) To get increased size in gooseberries the American sorts should have about one-half of the new growth removed each year. (*c*) To get rid of borers. (*d*) Pruning should be done when the plants are dormant.

Fruit.—The fruit varies much, both as to the size of each individual fruit and in the size of the bunches. The color of currants may be red, white, black, or purple. The color of gooseberries varies from a pale green to a deep red when ripe.

Picking and Marketing.—The currant is not as liable to injury in picking as most other small fruits, but it requires, nevertheless, considerable care to secure best results. Currants are generally preferred for jelly when a few green berries show on each bunch of fruit. For table dessert use they should be fully ripened and of the largest size. They are generally marketed in quart boxes, but in some sections nine-pound baskets are preferred. The fairest method of marketing the fruit is by the pound. Gooseberries are most in demand when fully grown but perfectly green.

Winter Protection.—(*a*) Winter protection is sometimes given by covering the branches of gooseberry bushes with earth or by laying them on the ground and covering with mulch. (*b*) By tying the tops of currants closely together for the winter. This prevents breakage by snow crusts, ice, etc.—(U. S. E. S. B. 178.)

CRANBERRY.

The small cranberry, *V. oxycoccus* Linn., is the Old World kind. It is a slender, creeping plant, with short filiform stems four inches to one foot long; leaves ovate, acute, or acuminate, ¼ inch long, with revolute margins; pedicels 1 to 4, terminal; corolla deeply 4-parted, the lobes reflexed; anthers exserted, with very long terminal tubes; berry red, globose, ¼ to 1-3 inch in diameter, 4-loculed. It is indigenous to sphagnum swamps in subarctic and Alpine regions of both Europe and America. In the United States it is reported from New England, Pennsylvania, Wisconsin, Michigan, and the Pacific Northwest.

The large or American cranberry, *V. macrocarpon* Ait., is a plant of low creeping habit, stems slender, elongated 1 to 4 feet, the flowering branches ascending; leaves oblong or oval, obtuse or retuse, 1-3 to ½ inch long, whitened beneath; pedicels, several, axillary and lateral; berry, red or reddish globose or pyriform, 1-3 to 1 inch long. The fruit of the cranberry is borne on short upright shoots of the previous season's growth. The flowers are borne in the axils of the leaves, one to three or four in a place, which gives the fruit the appearance of being distributed along the stem, a fact which is taken advantage of in harvesting. The mechanical devices used for this purpose are constructed so as to take advantage of this peculiarity.

Structurally, both species of the cranberry are closely allied to the so-called huckleberries. Botanically, they are classed merely as distinct species, all the blueberries, huckleberries, and cranberries being grouped in the one family (*Ericaceæ*). Of this group, many of which produce delicious dessert and culinary fruits, the cranberry is the only one which has been improved and extensively cultivated. It is also worthy of note as being one of the native fruits of America which has become an important commercial product and has won for itself a world-wide reputation.—(F. B. 176.)

Raising cranberries, like raising all other small fruit, is a very intensified industry, that is one requiring a large expenditure of capital and labor on a small area of ground. It is, therefore, of the utmost importance that the location be carefully made in order that the grower may have as nearly perfect control over these conditions as possible. The conditions essential for successful cranberry growing are, first, a proper soil; second, a sufficient supply of suitable water; third, adequate drainage; fourth, suitable topography for handling water; and fifth, accessibility to railroad and other means of communication.—(Wis. E. S. B. 119.)

At present the important commercial cranberry areas of the United States are situated in Massachusetts, New Jersey, and Wisconsin, with minor fields in Connecticut, Illinois, Indiana, Iowa, Kansas, Maine, Michigan, Minnesota, Nebraska, New Hampshire, New York, North Dakota, Oregon, Rhode Island, Washington, and West Virginia. Many of the possible areas for cranberry culture have not yet been taken up. A point brought out in the distribution of the plant is its limitation by climatic conditions. While it occurs as far south as Tennessee and North Carolina along the Allegheny Mountains, the high altitude has provided conditions under which a congenial environment for the plant has been maintained with a consequent preservation of the species in these now isolated areas.—(F. B. 176.)

STRAWBERRIES.

The graden strawberries of this country have come chiefly from the so-called Pine type of berries, which has been proved beyond question to have sprung from *Fragaria chiloensis,* a plant originally brought to Europe from Chile, but which is now known to be native to the western mountain regions of both North and South America. The first native strawberries to be brought under cultivation, however, were those of eastern North America, which belong to the scarlet class, the species being known to botanists as *Fragaria virginiana.* This class, as has been stated, has contributed only sparingly to our present variety list. The wild berry of Europe, which has always been held in more or less esteem because of its ever-bearing tendencies, has likewise contributed only meagerly to the garden sorts of its native countries and none whatever to the American list. The burden of the industry rests upon the Chilean plant.

The garden strawberry is an American product. It adapts itself to a wider range of latitude and to greater extremes in environment than any other cultivated fruit. It is universally liked and is cosmopolitan in its adaptations.—(F. B. 198.)

The Soil and Its Preparation.—Whether or not it is for a market or home patch, the results secured will, in a general way, be measured by the adaptation of the soil. As the strawberry contains a large amount of water and ripens at a time when a drought may be expected, the location selected should, so far as possible, provide a soil that is at least fairly retentive of moisture. Equal care should be taken that it is so thoroughly drained, either naturally or artificially, that water will at no time stand upon the surface and that in a very short time after a rain, the level of the standing water will be at least two feet below the surface. It is commonly said that any good corn soil will answer for strawberries, but, while this is true, on account of the much greater value of the crop, more care should be taken that it is in a proper physical condition and supplied with the needed amount of plant food.

As a rule, the lighter sandy loams should be avoided, as the crop will be likely to suffer from lack of water, while the stiff clays can seldom be properly worked in the spring, and if neglected are likely to bake so that the plants suffer more from the lack of water than upon the lighter sands.

In a general way, then, it will be seen that the heavier sandy loams and the lighter clay loams are best adapted for this crop, although good results will be obtained upon the lighter soils, if moisture can be provided. Fair returns are often obtained upon a soil of a mucky nature, as the water is generally so near the surface that drouths will have no effect, but two difficulties are frequently met with upon this class of soils, the first being the danger of frosts while the plants are in blossom, and the other that the plants make a rank growth and fail to form the necessary fruit buds. Where the mucky soil is in a basin, entirely or nearly surrounded by higher land, the blossoms seldom escape the frost, but if so situated that the cold air can drain off upon a lake, or still lower land, the danger will be lessened. After the land has been cropped for a number of years, the danger of the rank growth of plants will be greatly reduced, and if they are kept in hills, especially if a liberal amount of ground bone and ashes are used, a good crop of fruit can generally be expected upon this kind of soil and, as there will be but little danger from drouth, the fruit will be large and will bring the highest price.

In the home garden it is frequently impossible to find soil adapted to the growing of small fruits, and it will often pay to go to considerable expense in improving the physical condition of the soil. Where the soil is of a heavy nature, it will often be possible to spread over the surface and mix with it an inch or more of sand or sandy loam; good results will also be secured by the use of fine coal ashes, either from hard or soft coal, and a liberal dressing of partially decomposed stable manure will also aid in loosening and lightening the soil. If the soil is of too light a nature and it is not possible to add clay or heavy loam, the use of muck or wood ashes will have a beneficial effect, the former supplying humus and the latter tending to render the soil more compact. A soil improved in this way will be in good condition for other crops.

To precede the strawberries, a heavy clover sod is desirable, as this can be turned under and will not only provide a large amount of plant food, but it will so add to the humus in the soil that there will be far less danger from drouth. Cow-pea will in most parts of the United States make a fair growth, and where the ground is not needed for other crops can be grown and turned under previous to planting the strawberries.

Sod land is not desirable, as it is generally deficient in humus and plant food and frequently contains insect larvae, which may prove destructive to the plants. Almost any of the hoed crops may be used for one year previous to setting the plants and will leave the land in good condition for the strawberries, especially if it was heavily top-dressed with stable manure in the spring, or fall, previous to planting. Few soils will give the best results without the use of manure or fertilizer of some kind, and if the manure can be applied to the land at least one year before it is to be used for the strawberries it will decompose and will be in a suitable condition to yield up this plant food.

An application of fifteen to twenty loads of partially decomposed manure will be sufficient for most soils, but where wood ashes can be readily secured their use will be found profitable; fifty to one hundred bushels to the acre should be applied, after the land has been plowed and worked into the soil when dragging.

For commercial plantations it will hardly be desirable to use chemical fertilizers, as, with clover and other green crops and the addition of manure and wood ashes, fertilizers will add but slightly to the yield, and the expense will not be returned in the crops; for the private garden, however, if the manure can not be readily obtained, fertilizers may be used. A number of brands of fertilizers have been prepared by the different manufacturers, eespecially for the small fruits, and a thousand to fifteen hundred pounds per acre will give good results. For those who desire to prepare their own mixtures, however, we recommend one hundred pounds of nitrate of soda, eight hundred pounds of ground bone, and one hundred bushels of wood ashes, or, if these can not be obtained, four hundred pounds of potash salts, either muriate or sulphate. Although fall planting will give fair results under intensive culture, the best returns will ordinarily be secured from spring-set plants.

Unless the land is unusually heavy so that there will be danger of its puddling during the winter, it will be well to plow the land in the fall, and in the spring thoroughly pulverize the surface. With deep soil the furrows may be turned to the depth of seven or eight inches, but in a thin light soil, it will not be advisable to plow more than one-half inch deeper than the previous plowing. If the plowing was not done in the fall, it should be done in the spring as early as the ground can be worked and rolled to press the loose soils firmly down upon the under soil, in order that the upward movement of the water may not be checked. The dragging can hardly be too thorough, and especially if for any reason the plants can not be set as soon as the land has been prepared, the working should be kept up, at least once a week.

In dragging the ground the disk or cutaway harrow may be used upon heavy ground, but ordinarily the Acme or springtooth harrow followed by a smoothing harrow or weeder will give good results. If the soil is at all cloddy, good results will be obtained with the use of clod crusher or roller.

In this way many of the small weeds which may start will be destroyed, and the labor of hoeing and cultivating during the season will be greatly lessened. The aid from this is so great that many growers purposely delay the putting out of the plants for several weeks on this account only. In the small gardens it will be advisable to have the strawberry plats so arranged as to allow the use of the plow, as it will do better work than the spade as ordinarily handled, and in much less time. Where the area is sufficient to permit the use of a horse, the land should be marked off at the proper intervals; these will vary with the method selected for the handling of plants. When the matted row is used the distance should be 3½ to 4 feet, the latter distance being preferred by many growers; but when the hill system of planting is used, the rows may be as close as 2½ or 3 feet, while some growers who expect to work the ground both ways, mark the land in squares of 2 feet.

Plants and Planting.—All strawberry growers are aware that it is only the plants formed by the runners that should be used for the new plantation; these have yellowish white roots, and can thus be distinguished from the older plants, which have a long stem at the lower end of which are black or brown roots and rootlets, many of which are dead or broken. If plants of good quality, which can be depended upon to give large crops, are desired, those selected for planting should have good crowns and well developed roots. As a rule only the first plants on the runners should be used. When the plants are allowed to layer freely a large number of weak sets are produced, and, although these will grow, they give a small yield and the practice, if persisted in, will result in the running out of the variety.

The best plants can be secured from fields that have been grown but one year and which have not as yet fruited. The practice of obtaining plants from old plantations, although used by many persons, is not a good one, as continued fruiting cannot fail to sap the vitality of the plants and the runners produced by them will not give as good results as those from young plants. Whatever method of digging the plants is used, whether by spade, fork or potato hook, care should be taken that they are not exposed to the drying action of the sun or wind, and as soon as dug they should be placed in baskets, boxes or bags, and after being moistened should be put where they can be kept fresh and prevented from wilting.

Dealers in strawberry plants, when picking up the plants after they have been dug, generally remove the dead or diseased leaves and runners, and at the same time straighten out the roots and the remaining leaves. The plants are then tied in bundles or packed in baskets or boxes. Sometimes the operation of trimming and bunching the plants is not done in the field, as it is found easier to do this in a packing shed, or other place, where the work can be done in the shade and the danger of the wilting of the plants lessened. Even though one is merely digging a few plants for home use, the removal of the leaves and runners and the straightening out of the roots should not be neglected. Sometimes the setting of the plants is necessarily delayed until late in the season, when, if the air happens to be dry, there will be great danger of the wilting and perhaps the killing of the plants from the heat and dryness of the soil and air. Under these conditions it will be advisable to cut off the leaves except one or two of the smaller ones, as by thus reducing their surface the evaporation will be lessened. When plants have been purchased and have become dry or heated in the bundles, it will be advisable to untie the bundles and either place them in water up to the crowns in some cool shady place, or to heel them in, so that the soil will be in contact with roots of each plant, in moist soil where they can be shaded and occasionally sprinkled. In a few days the plants that have not been killed will recover, and it will be possible to throw out those that have been spoiled. In this way the labor of planting will be lessened and there will be no vacant places in the rows from the use of injured plants.

While it will not be best to pursue this course when large areas are to be set, any one having only a small plantation will find it advisable to put out the plants when the condition of the soil and atmosphere favor their growth. If they can be set just before a shower, or as soon as the ground is in suitable condition afterwards, their growth will generally be assured. Some go so far as to recommend the digging of the plants in the early morning, keeping them in a cool, moist cellar until late in the afternoon and then putting them out. Where this can be done there is undoubtedly a benefit from it, as the plants will contain much more moisture in the morning than when they have been exposed to the heat of the sun during the day, and by planting them in the early evening they will be less likely to wilt the following day than when the planting is done in the morning.

When the plants are being set, equal care should be taken that the roots are not exposed. If the soil has been so worked that a dust mulch has been provided, the soil that will be in contact with the roots will ordinarily have a sufficient amount of moisture, and watering will not be necessary, but, should the soil be dry, a pint or so of water should be given each plant before the planting has been completed; this will permit of the drawing of dry soil about it after the water has soaked in, and the baking of the soil about the plant, which otherwise might happen, will be prevented. In setting the plants a spade, dibble or trowel may be used, and if the work is properly done there will be little difference in the result secured. When the dibble or spade is used, a cut is made in the ground to the depth of 6 or 8 inches, and the soil is pressed back in either direction by a side movement of the handle; in the opening thus formed the roots are placed, care being taken that they are not cramped and that they are so spread out that the soil can be brought in contact with each of them. When large plants, with a thick mat of roots are used, this is particularly necessary, as otherwise the soil would only be in contact with a layer of roots upon the outside of this bundle and the inner roots will become dry and the plant will wilt. There is also considerable danger of loss if attention is not given to the depth at which the plants are set; they should be at such a depth that the bud will be just above the surface, as if deeper than this there will be danger that, especially on heavy soil, the bud can not make its way through the soil, while if not deep enough a part of the roots will be exposed and the plant will be very likely to dry out. If placed, perhaps, a quarter or half inch deeper than it grows in the field, this will be sufficient to allow for the settling of the plant and will leave it in about the right position. In planting with the trowel the same method may be used as with the dibble or spade, but with a few plants many think it will pay to take somewhat more pains with the planting; a large hole is dug and in the bottom of this a conical elevation is left, around and upon which the roots are spread.

After placing the plants at the right depth, the soil is pressed against them with the dibble, or hands, so that it will be in close contact with the roots, and the success of the planting will be increased if the feet are used to assist in packing the soil; pressure upon one side will generally suffice, but if the soil is sandy a foot may be placed at either side of the plant. The continued and repeated pressure with the feet about the plant, as practiced by some, is not advisable.

When the mound system of planting is used, the soil is drawn into the hole with the trowel and is firmed about the plant with the hands and feet. Some persons object to the use of the dibble in planting strawberries, and their objections can be well-sustained against the ordinary round dibble, or pointed stick, but the form used by most planters consists of a flat piece of steel or wood, 3 or 4 inches wide and nearly a foot long, which is pointed and with thin edges and provided with a D-shaped handle; with this a broad opening, something like that formed with a spade can be made and into this the roots can be spread. A man accustomed to the use of this tool will set nearly as many plants in well prepared soil, as two men when spades are used.

The distance between plants will depend somewhat upon the variety and also upon the method of cultivation. For the matted-row system, with varieties that are common, and that do not make many runners, the distance may be from 12 to 18 inches, but with new and choice varieties and such kinds as layer freely, intervals may be increased to two or even three feet. In hills, however, some growers, as mentioned above, set the plants two feet each way, while others have the rows three feet apart and the plants 12 to 15 inches apart in the rows.

Where the plants are in a small garden in which the cultivation is by hand, many prefer to grow the plants in beds. The plants are set about one foot each way and are kept in hills; four or five rows are grown and then a space of two or two and one-half feet is left for a walk, beyond which other beds are planted in a similar manner. With rich, moist soil this method gives excellent results in a small garden.

The Fall Planting of Strawberries.—Although not to be generally recommended, the fall planting of strawberries can sometimes be used with good results, but in order to succeed, special pains must be taken both with the soil and plants. As the season of growth will be comparatively short at best, the soil should be thoroughly prepared and enriched. In order to promote a rapid growth the use of a small amount of some soluble fertilizer rich in nitrogen will be advisable. The plants should be of some strong growing variety that will furnish large crowns and that are adapted to hill culture, and only the strongest and best should be selected. It will be advisable to use either pot plants, or to take the best runners that form, and set them close together in some spot where they can be shaded and watered. If placed about four inches apart each way they will develop strong roots, and when the ground has been properly prepared, they can be transplanted with but little check to their growth. The soil in which they are started should be of such a nature that they can be taken up with a ball of earth upon their roots. Unless water for irigation is at hand, the planting should be delayed until the ground has been well moistened by rain, but if possible the planting should be done before the first of September. Good results, however, can be secured if the plants are set out by the middle of September. The rows should be from 2 to 2½ feet apart and the plants ten inches in the rows. Even though the ground has been well enriched, it will be advisable to mulch the plants by spreading decomposed manure along each side of the rows. Under these conditions a good growth will be secured and the plants will make strong crowns before winter. The ground should be occasionally worked during the fall and up to the time of freezing weather, so that it will be entirely free from weeds. The ground should then be mulched, and in the spring receive a shallow cultivation. It will be desirable to replace the mulch before the blossoms have opened, and unless the winter mulch is sufficient to cover the ground so as to keep down the weeds and conserve the moisture, an additional amount should be employed.

This method of strawberry culture is not recommended for the general planter, but for the amateur and for the home garden, especially where the starting of a new plantation was neglected in the spring, it certainly is worthy of trial. However, as stated in the beginning, good results should not be expected, except under the most intensive cultivation and where the growth of the plants is not allowed to be checked. As the plants are grown in hills, the fruit will be of large size, and where an increased price can be obtained for fine fruit, the results will be satisfactory for market purposes.

Varieties—In selecting kinds for home use it is always desirable to include a sufficient number to provide a succession throughout the season, and there will be less occasion to consider firmness among the qualities to be desired than when they are grown for market purposes, but even more attention should be given to the flavor. While the hardiness and productiveness of the plants will always be the most important consideration, this characteristic even may be slightly sacrificed to produce varieties of high quality; regularity of form and a pleasing color will be desirable whether the varieties are for home use or market, and while the size should at least be medium, for home use, varieties that grow a large or very large sized berry will bring the most money for market varieties. As a rule the very large sorts are less regular in form and of inferior quality to the varieties that are medium sized. By the proper selection of soil and location a considerable range of season can be secured, as early kinds upon a light soil and southern exposure will be hastened in ripening, while late sorts upon a heavy soil with a northern slope will be somewhat retarded and a season covering four or five weeks can sometimes be secured in this way.—(Mich. E. S. B. 163.)

Cultivation.—The ground should be thoroughly cultivated during the entire growing season to keep it loose and friable. This condition of the soil is beneficial in several ways It allows the air to penetrate the soil which is necessary as roots need air; it retains moisture in the soil by preventing rapid evaporation from the surface; it assists in breaking down plant food which would otherwise remain insoluble and it keeps the ground free from weeds which rob the plants of moisture.

It is not a usual practice to cultivate the fruiting beds in spring, but this ought to be done to loosen up the soil so it will hold more moisture and evaporate less, and thus in case of drought the crop will not suffer so quickly if at all.—(Md. E. S. B. 124.)

Mulching.—Covering the surface of the soil with dead or decaying vegetable matter is the meaning of the term mulching as here used. Mulching in strawberry culture serves different purposes, depending upon the locality in which the plants are grown. A mulch acts as a protection from cold, prevents freezing and thawing and the consequent lifting of the plants ("heaving out"); it retards growth in cold regions by shading the crowns and maintaining a low soil temperature longer than in soil not mulched; it acts as a conserver of moisture, discourages weed growth by smothering the young seedling, and finally protects the fruit from contact with the soil.

Materials for Mulch.—The materials which can be used in mulching are various, but their value depends largely upon their freedom from weed seeds and their fitness to protect the plants without smothering them. Whole or cut straw free from grains, strawy manure from the horse stable, and pine straw from the forest are among the more common mulching materials. In certain sections marsh hay, either from fresh or salt water marshes, is a common and very satisfactory mulching material.

When to Apply the Mulch.—At the North where the soil is likely to freeze and thaw several times in the course of the winter, it is the practice to put on the mulch as soon as the ground is sufficiently frozen to allow driving upon it with a loaded cart or wagon. Where the freezing of the soil is only superficial or only temporary, if at all, the mulch serves the purpose of a protection from wind more than from frost, and in such sections the mulch is put on as soon as active growth ceases, usually early in December, and is allowed to remain until after the crop is harvested.

Some growers remove the mulch early and give the plants thorough cultivation before the fruits are half grown; then if it seems desirable to protect the fruits from the earth the mulch is replaced for this purpose. In other localities where heavy snows are of annual occurrence and where they remain throughout the winter, thus affording protection from repeated freezing and thawing, as well as preventing deep freezing of the soil, mulching is not generally practiced; if practiced at all a light mulch only can be used, as a heavy covering is likely to cause loss by smothering the plants.

Harvesting and Shipping.—The time of gathering the fruit, as well as the manner of handling, is governed by the use to which it is to be put. If for a local market, much riper fruits can be handled than when they are to be shipped long distances. The most progressive growers of strawberries for local markets not only give particular attention to the ripeness of the fruit, but to assorting and grading as well, only large perfect berries being placed in the first grade, and all small or soiled fruits in the second.

Shipment to Distant Markets.—For a distant market the fruits must be gathered as soon as fully grown and colored. When the fruits are removed from the plants they should go either into cooled shipping cases or into a cool storeroom where the temperature can be maintained at about 50° F. If this is impracticable, they should be placed in the shade in as cool a situation as possible. Fruits to be shipped in refrigerator boxes such as are used by the southern growers (Florida growers in particular), can be placed in the chilled carriers as soon as they have stood in the shade for a half hour. Such hardening off or chilling has much the same effect on soft fruits of this nature as it has upon flowers; it checks the ripening process and, while it does not entirely stop it, the effect is to deliver the fruits at the end of their journey in much better condition than when not so chilled. In this, as in all work of like nature, careful judgment is necessary. Too much cold is as bad as too little; in any case the chilling and icing should be considered merely as a means to an end. Experience has demonstrated that it is not advisable to attempt to hold soft fruits for any length of time in cold storage. The icing or shipping in refrigerator carriers allows the grower to bring his fruits to a higher state of perfection on the vines than when he is obliged to ship long distances without such appliances. For that reason alone this method of handling should be encouraged, as it gives the consumer a higher-grade product.

Receptacles.—Whether it is to be shipped in crates or refrigerator carriers or to be carried to the local market, for best results the fruit should not be rehandled after it is picked. The pickers should be trained to do the necessary assorting and grading as they pick the fruit in the receptacles in which it is to be marketed. In some localities, where the fruits become greatly soiled from mud splashing over them during heavy rains, growers find it advisable to assort and pack the fruits and also to rinse them in water before assorting and packing them. This is the system used by many of the most extensive and successful Florida growers.

The light splint-wood basket, holding 1 quart, is the most popular and most universallly used. Many different forms of box or basket have been designed, and various materials other than wood have been used in their construction, but up to the present none has met with general adoption.

As above stated, the refrigerator carrier is almost universally used for long-distance shipment. For shorter hauls, not more than a night's ride, the ordinary slat crate, holding 24 to 36 quart boxes, is very popular; it is also the package in general use for local marketing.

Picking.—In the commercial production of strawberries considerable numbers of persons have to be employed in picking the fruit and as this work is usually paid for by the quart it becomes necessary to have some system of keeping account of the work done by each individual. Different growers employ different schemes. Some issue a check or card for each quart of berries harvested, and where a certain number have been obtained by the picker these are exchanged for one of larger denomination. This has the advantage of reducing the number of quart checks necessary. The one objection to this plan is the liability to loss on the part of the pickers. Other growers use a tag similar to a shipping tag, which is fastened to the clothing of the picker, and as the fruit is delivered to the inspector credit for as many quarts as have been picked is punched out of the tag. Others use only a system of bookkeeping, the picker delivering his fruit to the inspector and depending upon the accuracy of the tallyman for the count. The system of recording the work of each picker will largely depend upon the character of the help employed and the extent of the work to be done. The plan that suits the circumstances of one may not be that which will meet the requirements of another. Each grower must study this problem for himself, and decide upon the plan best adapted to his conditions.

A convenience which is almost a necessity is a picking stand carrying from 4 to 6 boxes. The short legs hold the tray off the ground and prevent injury to the fruit, while the number of baskets (4 or 6) allows the picker to grade the berries as gathered.—(F. B. 198.)

CITRUS FRUIT.

Citrus Aurantium.—This species includes the group *sinensis* or ordinary sweet oranges with which we are all familiar, such as Washington Navel, Mediterranean Sweet, etc.

Botanical species.	Botanical varieties.	Horticultural races.	Horticultural varieties.
I. *Trifoliata*			Trifoliatas.
II. *Aurantium*	*amara*		Sour. Bitter sweet. Seville.
	bergamia		Bergamot orange.
	sinesis	The common oranges.	Bahia. Valencia. Homosassa. Pineapple. (Also other varieties.)
III. *Nobilis*		The mandarin group.	Satsuma. China (mandarin). Dancy (tangerine). Oneco. King.
IV. *Decumana*		Pomelo (grapefruit)	Royal. Pernambuco. Triumph. (Also other varieties.)
		Shaddock	Paradise. Forbidden Fruit. (Also other varieties.)
V. *Japonica*		Kumquats	Nagami. Marumi. (Also other varieties.)
VI. *Medica*	*genuina*	Citron	Corsican. Lyman. Orange. (Also other varieties.)
	lemon	Lemon	Lisbon. Villa Franca. Sicily. Eureka. (Also other varieties.)
	acida	Lime	Imperial. Mexican. Persian. (Also other varieties.)

—(F. B. 223.)

Citrus Vulgaris.—This is the sour or bitter bigarade orange commonly grown as an ornamental tree. This may more properly be called the Seville orange.

Citrus Decumana.—Here are included the pomelos or grapefruits, the shaddock, etc. They are vigorous growing trees with very dark green leaves, very prolific in bearing.

Citrus Medica.—The citron, lemon, sour lime and sweet lime all belong to this species. They are in general far more sensitive to frost than the three preceding species.

Citrus Japonica.—This includes the kumquats or *kin kans,* all small bushy plants from Cochin China. Fruits small with mostly acid pulp and sweet rinds, valuable for preserving.

Citrus Nobilis.—This is the Mandarin or kid-glove orange. Here belong such small, oblate, loose-skinned varieties as China, King, Dancy tangerine, and Satsuma.

Citrus Trifoliata.—This is the only deciduous orange. The fruit is not edible. It is very hardy, being used as an outdoor ornamental in the Eastern States as far north as Washington City.

In certain locations climatic and other conditions permit the growing of all the above enumerated citrus fruits. The sweet oranges are the citrus fruits of most commercial importance. While the production of oranges in California and Florida has increased by leaps and bounds within late years, still the markets seem ready to absorb additional quantities of first-class sweet oranges at remunerative prices.—(Ariz. E. S. B. 58.)

Experience has taught that no variety of citrus is pre-eminently useful for all portions of the world where this fruit is grown. As an illustration we have the Bahia, or Washington navel orange, which is pre-eminently adapted for California, but of little value in Florida or the West Indies, since it produces only a small crop except on rough-lemon stock, which stock is only adapted to a restricted area. Certain varieties of pomelo have exquisite flavor when fruited in Florida, but are not of the same excellence when grown in California. The pineapple orange and the Indian River orange are among the finest of fruits when grown in the sections where they originated, but when produced in Jamaica they can not be said to have superior qualities.

It becomes necessary, therefore, to test the particular variety in the section into which it is to be introduced. Some of the varieties are excellent in places far removed from one another, as is illustrated by the Satsuma, or onshu, an introduction from Japan, and the Bahia orange, which was brought from Brazil by the United States Department of Agriculture and is now so extensively grown in California. The last-named variety produces fruit of excellent quality when grown in Florida, but, as stated, is not prolific except on rought-lemon stock. Frequently the most important varieties of citrus for any given locality are those which have originated as seedlings in that section, and ocasionally they may arise as bud varieties. An illustration of a variety arising as a bud variation is the Surprise navel, originating in Mr. E. S. Hubbard's grove at Federal Point, Fla., from buds received from California. Seedlings, as a rule, "sport," or are exceedingly variable; they, however, come true to seed within certain limitations. So far as known, a pomelo can not originate from an orange seed except where an orange flower is pollinated from a pomelo, and it is then not a true pomelo. Seedlings from the mandarin group reproduce a typical mandarin fruit. Seedlings from the sweet orange produce a typical sweet orange. Seedlings from pomelos produce pomelos of varying qualities.—(F. B. 238.)

THE ORANGE.

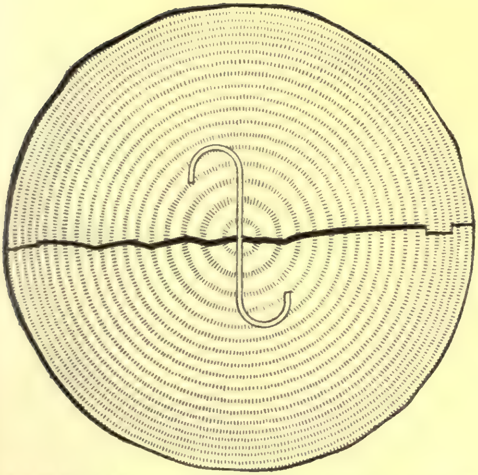
The orange is king of the citrus fruits. It may be treated as a type representing the other members of the group in many particulars relating to soils and cultural methods. In some respects special treatment is required for lemons, limes, and pomelos, as described in the sections devoted to these fruits.—(Hawaii E. S. B. 9.)

Climate.—In general it may be stated that in all regions in which the temperature does not fall below 18° above zero nor rise above 100° F., and where there is sufficient moisture, citrus fruits may be produced. There are, however, localities within these limitations that can not be said to be good citrus-growing sections. In some places, although the trees grow luxuriantly, heavy rainfalls occur at the time when the fruits are maturing, making it impossible to gather and market them. In others the conditions for vegetative growth are so favorable that very little fruit sets. Regions that are excessively dry may, however, be utilized for citrus culture when irrigation can be practiced. The more nearly the northern limit of the citrus belt is approached, the more sprightly and deliciously flavored the fruit becomes, some of the very best fruit being marketed from areas where the trees every winter are in danger of being frozen out.

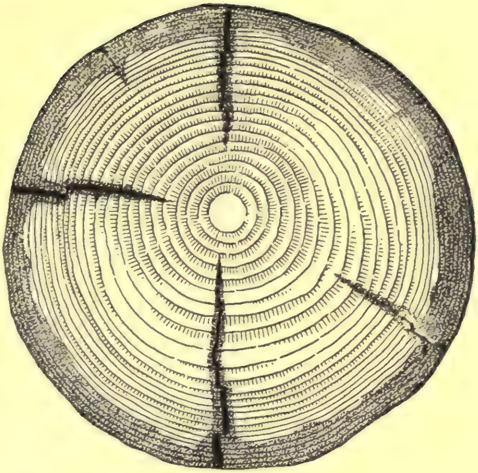
The ideal climate for citrus growing is one in which the rainfall occurs after the fruit has been shipped and before the new crop begins to ripen. The rainfall should not be excessive, certainly not more than 50 to 70 inches annually, and the winter temperature should not go below 26° to 27° F. of continued cold, though a lower temperature may be withstood for an hour or more without killing the trees Orange trees in a thoroughly dormant condition can withstand a temperature as low as 24° F. if this is not continued for more than a few hours at a time. A very sharp turn to 18° F., if for only a few hours, will entirely defoliate trees in the most dormant condition, while it is likely to kill the larger proportion of those in active growth. Small trees under 8 to 10 feet high, with poorly protected trunks, are very apt to be cut to the ground under these conditions Sometimes snow falls and remains on the trees for some hours without seriously damaging orange trees; but this is of rare occurrence.—(F. B. 238.)

Soil.—The orange will grow successfully in a great variety of soils, yet there are a few essential characteristics of a good orange soil which can not be overlooked with safety by the prospective grower. The soil must be abundantly moist but must allow good drainage. It should be deep and rich. It is best to avoid the extremes of heavy and loose texture, though some very heavy soils have given excellent results, particularly when overlaid by a stratum of lighter character. Shallow soils and those underlaid with hard pan near the surface are unsuited to orange culture.

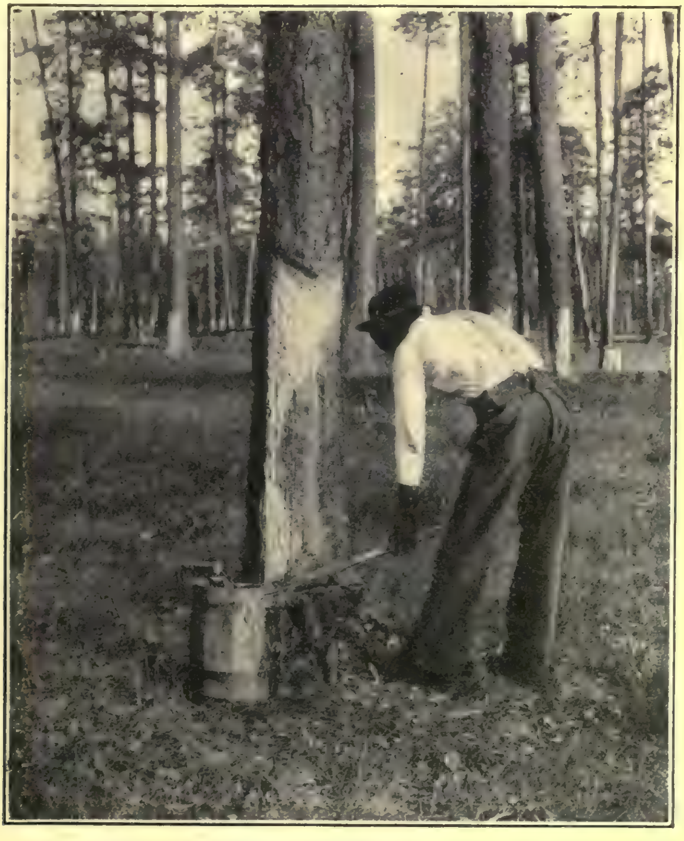
Preparation of the Soil.—The orange makes very indifferent success of the "hole-in-the-grass" method of cultivation. Where the space is too limited to admit of anything like orchard cultivation the orange will often grow and produce fair fruit, but if a serious attempt is made to grow more than one or two trees they should be placed where their rights to full possession of the soil immediately surrounding them will not be disputed by grass, weeds, or other trees. The first step, then, in preparation is to clear the land, if it be occupied by any other trees If the soil be virgin it would be well to plant some other crop for a year or two, plowing it deeply and keeping it in good tilth. It is important that the soil be worked deeply for otherwise the trees, when set out, are likely to form surface rather than deepfeeding roots. Surface-rooted plants suffer much from dry weather. Plow deeply, harrow thoroughly, and get the ground in as friable a condition as possible. The trees may be procured from nurserymen or they may be propagated by the orchardist. If the latter plan is adopted there are



An S Iron Driven into But of Hole to Prevent Opening of Seasoned Checks.
Dept. of Agr.



Decay of Untreated Pole. Shaded Portions. Checks Hasten Decay.



Side View of Box Cut in Tree for Collecting Crude Turpentine.
Dept. of Agr.

several means at hand for reproducing the orange or other citrus trees.

Seeds.—The easiest method of propagation is by seed, but this plan is unsatisfactory when used alone. The seeds of these, as of many other plants, can not be relied upon to reproduce the variety from which they are taken, and for this and other reasons the seedling orange has ceased to be desirable as a commercial fruit. Almost any seedling sweet orange, given proper care and cultivations, will produce fruit that is edible, but seedlings have no uniformity as to size, thickness of rind, flavor, number of seeds, or other essential characteristics. Occasionally a tree is found producing fruit which combines the elements of a good merchantable orange, but such cases are rare. Seed propagation must, for the reasons given above, be supplemented by budding and grafting. This consists essentially in placing a small part of a tree of a known variety in such contact with the seedling tree that it unites with the latter. Then, by removing all of the original tree above the point of union, this small part which is inserted grows until it forms a new top for the tree. It must be distinctly understood that the bud or scion inserted does not convert any remaining parts of the former tree top into the new variety. Budding is not inoculation, as some have supposed.

In growing the seedling trees which are to be budded the seeds may be started in an open seed bed or in deep boxes. In any case the soil should be well drained and friable and should be made fairly rich, preferably by the use of commercial fertilizers, applied two or three weeks before planting. The seeds should be planted while fresh and should not be allowed to dry out. If it is desired to hold them for some time before planting they may be preserved by burying deeply in moist sand. If large numbers of seeds are desired the fruits may be allowed to decay and the seeds washed out later through a sieve. The seed may be planted not more than 1 inch deep, in rows 3 or 4 inches apart, or wider if it is desired to keep them clean with the hoe. They will not germinate for about six weeks. When they have made a growth of about 6 inches they may be removed and placed in nursery rows, where the soil has been well prepared and fertilized. In the nursery the plants may stand 12 to 18 inches apart, in rows 4 to 6 feet apart. Keep the ground well tilled, moist, and rich enough to produce a vigorous, steady growth. At about two years from seed the young trees will be large enough to bud, and a year or two later may be dug up and set out in the orchard or grove.

Budding and Grafting.—There are several methods of budding and grafting citrus trees, but that most commonly used is known as "shield" budding. Select budding wood, bearing well-matured buds and not more than 1 year old, but old enough to have lost the angular form characteristic of the youngest orange wood. It is best to cut these pieces from the tree of the desired variety when it is dormant and preserve them until the stocks into which they are to be set are in a proper condition. They may be preserved by placing them in a box in slightly moistened sawdust and burying the box 6 to 10 inches deep in a shady place in the soil. The leaves should first be removed.

When the stocks are dormant the bark can not easily be separated from the wood, but when they have commenced to make a new growth, which they do several times during the year, the buds may be set. In a frostless climate it is well to set the bud several inches above the ground. At such a point make a vertical slit in the bark of the stock about 1½ inches long, and at the lower end of this make a horizontal incision with the edge of the knife turned slightly upward. Taking the bud wood in the left hand, place the knife about half an inch below a bud and make a shallow cut, removing the bud with about 1 inch of bark. Now, with the knife raise the corners of the bark on the stock where the two incisions were made, and, being careful not to invert the bud, insert it, pushing it up the vertical slit. When in place, bind it snugly, but not too tight. One of the best tying materials is muslin which has been saturated with grafting wax. Simply bind it about the stock, covering all the incisions but not the bud, and so lapping it that it will shed water. It will hold tightly enough without any tying. Unwaxed strips of cotton, candle wicking, raffia, or any such soft material may be used to tie the buds, but the use of the waxed muslin gives extra assurance of success, especially in a climate where evaporation goes on rapidly.

About ten days or two weeks after setting the buds examine them to see whether they have united with the stocks. If they are still green and a grayish line of new growth is seen where the incisions were made, it may be concluded that a union has been effected. If so, cut off or partly cut off the stock a few inches above the bud, and the latter will soon begin to grow. The growing shoot may be tied to this remaining part of the stock until it has attained a growth of 12 to 15 inches, at which time it is best to cut off the stock close to the bud with a slanting cut Then it may be necessary to support the new growth by tying it to a stake, using some soft tying material

This is known as "shield" budding by the inverted T method. The ordinary T method is more commonly practiced with deciduous trees and is also much used with citrus species. It is precisely the same as the method above described, except that the horizontal incision is at the top instead of at the bottom of the vertical cut in the bark of the stock.

The Orange on Other Roots.—In some citrus countries it has been found a distinct advantage to bud oranges upon seedlings of other species. Each species of citrus has its peculiar adaptations to climate and soil, which may be taken advantage of by the propagator who wishes to use them as stocks upon which to bud. In sections where this class of fruit has long received careful attention the matter of desirable stocks for certain localities and species has been fairly well worked out.

The sweet orange is itself a very satisfactory stock for average conditions, but is being largely abandoned in districts where the foot-rot, or gum disease, is prevalent because of its extreme susceptibility to this malady. It is not thought to be quite so deep rooted as some other species, which would not be to its advantage in deep dry soils.

The pomelo, or grape fruit, produces exceedingly vigorous growth, will probably stand more dry weather than the sweet orange, and is resistant to the foot-rot disease.

The lime has been used to a limited extent as a stock and affords peculiar advantages if it is desired to grow a few oranges on rocky or dry soil.

The sour orange (*Citrus aurantium amara*) and the rough lemon (*C. limonum*) have proved very popular in Florida, the former for the damp soils, the latter for higher and dry soils. The rough lemon produces a more vigorous growth in the bud worked upon it than even the pomelo.

Layering.—Another method of propagation, which is often very convenient for use in the home garden, but which is of no importance commercially, is that known as "air layering," or "Chinese layering." This consists in removing a ring of bark from one of the branches, or partly severing it, and surrounding the wound with moist soil until roots are formed. For this purpose select a branch conveniently located and about 1½ inches in diameter. Remove a ring of bark about as wide as the diameter of the branch. Surround about 7 or 8 inches of the branch at the girdled point with soil, held in place by being bound around with sacking or by a box which has been previously constructed for the purpose with openings on the sides to admit the branch. The soil must be kept constantly moist. When the roots have formed and filled the soil cut back the top, cut off the branch below the ball of soil and plant it, without removing the wrapping, if the latter be sacking or any material which will decay rapidly in the soil.

It is much simpler to practice ordinary layering by bending one of the lower branches to the ground, where possible, but most of the orange and other citrus trees are headed so high that this would be impracticable. The only advantage of any method of layering is that a few bearing trees may be produced more rapidly than by planting the seed and awaiting its growth for budding.

Removing the Trees from the Nursery.—This must be done with special care. They should be dug up with as little injury as possible to the root system, and it is imperative that the roots be kept moist until they are safely replaced in the ground. It is a good practice to "puddle" the roots by dipping them in a puddle of thick mud and water. "Balling" the roots of citrus trees is a practice which entails some extra trouble, but the results attained are often sufficient to warrant even greater expense. This consists in removing each tree with a ball of soil containing the roots. To do this, dig a trench 18 inches deep along one side of the row of trees and about 6 inches away from them. Remove the surface soil down nearly to the first lateral roots and then, with a sharp spade, cut down on the three remaining sides, severing all the roots. From the trench side the tap-root may be cut off and the tree carefully lifted and placed upon a grain sack. The corners of the block of earth are then rounded off and the ends of the sack are brought up about the ball and tied to the trunk. A rope is also run around the ball and under it. The tree may then be carried to its destination and planted without removing the sack, which will soon decay in the soil. Citrus trees may, in this way, be transported long distances with comparative safety.

Planting the Grove.—It is important that the trees be set in straight lines for business-like and neat appearance and for convenience in tillage. There are various methods of arranging the trees, but the simplest is that known as the rectangular system. To use this system, determine upon a base line for the first row, and parallel to which all the rows of trees are to stand. Standing at the end of this row, fix upon a line at right angles to this base line. This may be done by nailing together two 10-foot boards at right angles, by use of a square and bracing them with a third board. Place this device upon the ground so that one side of it will be exactly on the base line. The other side will determine the rows as they run crosswise. Place straight stakes along both these rows at the distances at which the trees are to be planted, and repeat the operation for the remaining two sides. These stakes all around the field will determine every row. The rows should now be completed by setting stakes accurately at the proper distances, a stake to mark the place for each tree.

Oranges may be planted from 20 to 30 feet apart, according to variety, soils, and personal taste. It is desirable to have a greater distance between the rows than between the trees in the row.

If the whole field has been thoroughly and deeply prepared, as it should have been, it will only be necessary to dig holes of ample size to admit the root system without cramping. If there has been any neglect in preparation, much larger holes will be required. When the hole is dug, the stake must of course be removed, and in order to mark the exact point where the tree is to be placed, a planting board may be used. This is made of a board about 4 inches wide and 5 to 5½ feet long. A hole is made in each end, and exactly midway between these two and on the edge of the board hole at each end of the board. Raise the board and the tree stake in the central notch. Then put a wooden pin or short stake in the hole at each end of the board. Raise the board and the tree stake may be removed. When the tree is to be set, place the planting board down again with the pins through each end. The trunk of the tree must occupy the central notch of the board.

Setting the Tree.—This must be done with care. If its roots have not been balled and sacked, some will be more or less dried and some may have been bruised. These should be cut back to sound and living wood before the tree is set out. Placing good surface soil in the bottom of the hole, set the tree upon it and spread out the roots so that they will occupy their natural position as nearly as may be possible. The tree must not stand deeper in the soil than it did in the nursery. Many trees are killed or stunted by being planted too deep. Fill in the soil gradually and press it about the roots, but not too tightly, unless it be a very light soil. If water is available, it is well to settle the soil about the roots by its use, but in this case, tramping must not be done on the wet soil.

Cutting Back the Top of the Tree.—Cutting back is necessary, unless the tree has been removed with a large ball of earth. It has lost a large part of its root system in being moved and can not support the whole top. This pruning may be done either before or after planting. The main stem or leader of the tree should be cut back to a bud or branch, about 2½ feet to 3 feet from the ground and the side branches should all be cut back, more or less severely, according to the injury which has been sustained by the root system.

Tillage.—The orange requires good, clean tillage. If weeds and grass are allowed to occupy the ground during the period of growth the grove will suffer. In the matter of plowing there is a difference of opinion. Most orange orchards, however, are plowed at least once a year. Those that are not plowed are constantly stirred to almost as great a depth by the use of very effective harrows and cultivators. The harrow or cultivator should be used often enough to keep the surface soil loose. In California it has been found a distinct advantage to vary the depth of tillage from year to year, thus avoiding what is known as "plow sole," or "hard pan," a hard and impervious layer of soil which sometimes forms when the soil is continuously tilled to the same depth.

Irrigation.—All citrus trees require liberal amounts of water. The exact quantity necesary can not be stated, since it will vary with the character of the soil, the distribution of the rainfall, and the care taken in its conservation in the soil. In California it may be said in general to vary from 24 to 44 inches in depth per year, including precipitation and irrigation, but it is carefully applied and conserved so as to make the very best use of it. These figures must be regarded not as a prescription, but simply as a standard of measurement for varying conditions. The number of applications into which a given amount of water will be divided also varies. In California the citrus orchards are irrigated from three to eight times per year. The best practice in these matters can be determined only by the grower himself after study of his local conditions.

Method of Application.—Perhaps the simplest method for the application of irrigation water is that known as the "furrow system," which consists in plowing a number of furrows in the spaces between the rows of trees and in turning the water into these from the more permanent ditches or flumes which run along the ends of the rows.

Tillage should follow irrigation as soon as the land is dry enough to admit of it.

Fertilization.—Citrus trees require the liberal use of fertilizers, unless the soil be unusually rich. Few fruit trees show such marked results from the quantity and kind of fertilizers used; but it must be constantly remembered that fertilizing is but one of the links in the chain of good culture and will be quite useless if tillage, moisture supply, and other essentials be neglected.

No prescription can be given for fertilizing which will fit all cases, but a few guiding principles may be stated. As in the case of all fruits, the same proportions of fertilizing ingredients should not be used on bearing trees as on young orchards which have not yet begun to produce fruit. Trees which should be growing rapidly but have not arrived at the bearing age require relatively large amounts of nitrogen and much less potash than those producing heavy crops. The latter require a higher percentage of both potash and phosphoric acid in the mixture. In Florida the following proportions have proved popular: For young trees: Phosphoric acid, 6 per cent; potash, 8 per cent; nitrogen, 4 per cent. For producing trees: Phosphoric acid, 8 per cent; potash, 12 per cent; nitrogen, 3½ per cent. A ton of such a fertilizer might be constituted as follows:

Constituents.	For young trees.	For bearing trees.
	Pounds.	*Pounds.*
Acid phosphate	800	1,066
High-grade sulphate of potash	314	470
Nitrate of soda	250	......
Sulphate of ammonia	190	333
Makeweight[a]	446	131
	2,000	2,000

[a] Makeweight is material which has no fertilizing value, but which must necessarily be used if certain proportions such as the above are to be maintained in the mixed fertilizer.

An abundant supply of nitrogen will be indicated by a good growth and dark-green foliage. An excess of nitrogen, accompanied by a lack of potash, is manifested by rank growth and comparative barrenness, and, in the fruit, a thick rind and abundant rag (the tough, fibrous part of the interior of the fruit). Liberal supplies of potash tend to greater fruitfulness, thinness of rind, less rag, and better keeping qualities.

The fertilizing ingredients may be bought unmixed or they may be mixed to order at the factory. Sulphate of potash is usually preferred to muriate. Acid phosphate is a good source of phosphoric acid. As to the best source of nitrogen, experiences differ. In California, organic sources, such as dried blood, tankage and stable manure, have proved satisfactory, as well as the chemicals nitrate of soda and sulphate of ammonia. In Florida, on the other hand, the use of organic nitrogen has proved a prolific source of die-back and other troubles and is being abandoned. Leguminous cover crops may, however, often be used as a cheap and very satisfactory source of nitrogen. These do not seem to have produced the disastrous results in Florida which have followed the use of other organic fertilizers.

Cover Crops.—Cover crops, if judiciously used, may be a very decided benefit to citrus orchards. In fact, they will, in a long term of years, be found necessary to maintain the fertility of the soil. Constant, clean culture would in time exhaust the soil of its supply of humus and render it unable to retain adequate moisture. Humus is also a source of nitrogen supply, and when leguminous plants are used as cover crops very considerable amounts of this most expensive of commercial plant foods are added to the soil.

In the use of cover crops, however, good judgment must be exercised. It will not do, for example, to plant such crops in a citrus orchard at the beginning of the dry season, unless abundant water for irrigation be available, since they make large demands for moisture. If planted at the beginning of the wet season, there is likely to be enough moisture to supply both trees and legumes, and the latter may be plowed under before the approach of dry weather. It has been very reasonably suggested by some that in a tropical climate it may be better to cut a cover crop and allow it to dry and partly rot before plowing it under, there being thus less danger of producing acidity in the soil. The best plants to use for this purpose must be determined by experiment in each locality.

Orange and other citrus trees, except the lemon, require little pruning after the head has been properly formed. It is of great importance that the tree be given a proper shape by judicious pruning and pinching during the first years of its orchard life. The aim should be to secure a low-headed, symmetrical tree, of upright growth, covered with a compact, but not crowded, wall of foliage. To secure this shape, begin when the tree is first set out. Its main stem or leader should then be cut back to within about 2½ or 3 feet of the ground. The laterals may be treated in either of two ways. They may be allowed to start and grow as low as 1 foot from the ground, with a view to gradually removing them later up to a height of 2 feet, after these lower ones have borne the first fruit, or from the start all branches below 20 inches or 2 feet may be suppressed. If the tree grows very rapidly it will often be necessary to pinch back the new growth to prevent the drooping habit, which is acquired by the young shoots becoming too long and heavy to support their own weight before woody tissue has been formed. During this formative period. and in fact throughout the life of the tree, any ambitious branches which tend to shoot out far beyond the others should be kept back. Otherwise the tree will lose its symmetrical form and become "shouldered."

Dead twigs in the fruit-producing area should be removed, and it is generally recommended also to cut out all dead branches in the interior of the tree. If the orchard has long been neglected and given over to the attacks of scale insects, some thinning out of the branches will be necessary before effective spraying can be done. If this condition has become greatly aggravated, it may be better to cut off all the main branches a short distance from the trunk and allow the tree to form a new head, which it will do very rapidly and will soon again be in condition for fruit bearing. With the exceptions noted above, the orange and all citrus fruits but the lemon will require little pruning.

When it is necessary for any reason to remove a branch, it should be so done that the wound will rapidly heal by the growth of new tissue from under the surrounding bark. The cut should be made with a sharp knife or pair of pruning shears, or with a saw if the branch is a large one. If the saw is used, it will aid the healing to make the cut smooth by means of a sharp knife. The direction and position of the cut are of vital importance. It should be as close as possible to the trunk or larger branch, to which also it should be parallel. If the wound is large, some dressing should be applied and nothing gives more satisfactory results than lead paint.

Gathering and Marketing the Fruit.—Budded trees should begin to bear a small crop two or three years after setting out in the orchard. They will then be about six years old from seed or four years from budding.

Citrus fruits should not be pulled from the trees as are deciduous fruits. The stems must be cut close to the fruit by means of clippers made for the purpose, and which may be purchased at small cost. Great care is necessary in handling to avoid even the slightest bruising, which though it may not be apparent at first would be conspicuous later, and injure the sale and keeping qualities of the fruit. Oranges should be well matured before picking. Some varieties should not be allowed to remain long on the trees after they have arrived at this stage. Others allow of more latitude in the time of picking.

It is very often necessary to wash the fruit to remove sooty mold, dust, or an occasional scale insect. This may be done with an ordinary brush. There are simple machines for the purpose commonly used where citrus fruits are grown on a large scale. It should be done with care, so that the surface of the rind will not be broken or injured. Sometimes fancy fruits are polished with a soft flannel cloth or other such material.

When oranges are taken from the trees the rind is filled with moisture. It is necessary to hold them for several days before packing to allow the excessive moisture to evaporate. This is known as curing. The fruit is spread out in shallow bins or in small, open boxes, and kept where there will be a free circulation of cool, dry air. When thus cured the rind becomes shrunken and leathery, and will yield without bruising to the pressure which is necessary in packing. After this curing process is complete, bruises which occurred in picking may often be detected and the fruit thrown out. A further advantage is that, there being less moisture escaping in the shipping case, the loss from decay in transit is considerably reduced.

Modern fruit markets demand that fruit of any kind be well graded. Large and small specimens or those of different varieties should never be placed in the same package. Only clean, smooth, uniform fruit should be placed before the buyer. The importance of this can not be overestimated. If oranges have become russet in color by the attack of the rust mite they should be placed upon the market in a separate class and be so labeled. After being wrapped with tissue paper of good quality the fruits are placed in the box, there being a definite number of a given size in each package. The standard box in California is 11½ by 11½ by 26 inches, divided into two equal compartments by a cross partition. When the last layer of fruit is placed it should project about three-quarters of an inch above the edges of the box. The cover is then put on top and brought down in place by means of a lever. Though there are machines for the purpose in the market, a simple home contrivance will do the work satisfactorily. Nail a piece of 2 by 3 against the wall about on a level with the top of the box, and place the lever under this and over the box. A frame should be placed under the lever to equalize the pressure on the ends of the cover, and on the center also if it is intended to nail the cover at this point. Nail the box securely, label it truthfully, and it is ready for shipment.

Working New Varieties into Old Trees.—It is often desired to work over old trees with new varieties. It is now becoming very common to insert buds into the old bark of the main branches, but this requires special treatment, and for the beginner it would probably be best to follow the older method, which consists in cutting back the main branches a short distance from the trunk and inserting buds in the new growth which starts out. This budding may be done as with nursery stock.

Varieties of Oranges.—The variety problem is a local factor in any fruit industry. Varieties which are eminently successful in one district may give poor satisfaction in some other place equally well adapted to the industry. As an example of this, among citrus fruits the Bahia or Washington Navel orange may be cited. This variety, which, by its fine quality, has become the leader in California, has had very indifferent success in Florida. Some varieties, however, have a wide range of adaptability. The Valencia, St. Michael, and Maltese Blood appear on lists of desirable varieties both in Florida and California.—(Hawaii E. S. B. 9.)

THE LEMON.

In most particulars the lemon may receive essentially the same treatment as that described for the orange. The methods of propagation, tillage, irrigation, etc., are the same. It is seldom grown on its own roots. In California the favorite stock for the lemon is the sweet orange seedling. The pruning of the lemon trees and the curing of the fruit are quite distinct from the practice in relation to oranges.

Pruning.—The lemon has not the same tendency to compactness of form as is found in the orange tree. Its habit is straggling, and if left to itself it will produce its fruit on the ends of long branches. It therefore requires a method of pruning persistently pursued if the best results are to be secured. There are several elaborate systems of pruning which are in use, but the aim of them all is to produce a compact, but not too dense, low-headed tree with a large amount of bearing surface on easily accessible branches. This is secured by cutting back the leader or main stem of the tree when it is set and forcing out stray branches, three or four of which are selected to form the framework of the tree. These in turn are persistently pinched or cut back and encouraged to assume a nearly horizontal position. Any branches that start to make a strong growth in a vertical direction are cut out. This continuous pinching and cutting back tends, however, to produce a very dense mass of branches and foliage and some thinning out becomes necessary. The general result of such systems is a low, flat-topped tree, from which most of the fruit may be gathered without the use of long ladders.

Picking.—Lemons are picked while the color is green, the time of picking being governed by the size attained by the fruit. After picking it requires from one to several weeks to cure them properly for market. This is usually done in specially constructed houses, in tents, or in banks.—(F. B. 238.)

Curing.—The curing and storing of lemons is a much more prolonged and difficult process than that of oranges. Simple methods of curing may suffice when the lemons can soon be marketed, but when it is intended to hold them for many months for the best markets special devices are required and the skill of one who has had experience in the business. The objects aimed at are, in part, the same as in the case of the orange, but further, the lemon must attain its proper color, the thickness of the rind must be greatly reduced, the acidity increased, and the fruit preserved in marketable condition for a long time. This is attained by holding the fruit in a dark place, in a temperature as nearly uniform as possible and with sufficient ventilation to prevent molding and decay, but not enough to cause the wilting of the fruit. Where the business is conducted on a large scale curing houses are provided.

Varieties.—There are only a few varieties of lemons that are successful commercially. The variety Villa Franca is probably the most extensively grown in Florida and California. The Eureka and Lisbon are also popular varieties. The Sicily has been reported as doing unusually well in Hamakua and Olaa and probably will prove to be well suited to many other parts of the Territory of Hawaii. Dr. N. Russel, of Mountainview, Olaa, in speaking of trees of this variety, said they grow quickly and give excellent fruit, superior to California lemons.

POMELOS, GRAPEFRUITS AND SHADDOCKS.

There is some confusion in the use of the terms "pomelo," "grapefruit," and "shaddock." From the standpoint of the botanist these are simply different names applied to the same species, *Citrus decumana,* but horticulturally some distinctions may be made. The term "shaddock" is now being reserved for extremely large, coarse, and almost inedible forms of the species. They are practically useless, except for ornamentation and curiosity. The "pomelo" is precisely the same as the "grapefruit," with which everyone is familiar in the markets. The name "grapefruit" has arisen from the fact that they are borne in clusters like grapes in a bunch. This is the designation by which they are most commonly known. The term "pomelo," however, is the one which is now given the preference, and has been adopted by the U. S. Department of Agriculture, by the American Pomological Society, and by the State horticultural societies of both California and Florida.

Varieties.—The fruits commonly seen in the markets are budded varieties and sustain the same relation to the seedling pomelos of gardens and dooryards as do seedling oranges to the imported varieties, such as the Navel or the Valencia. Some seedlings are of peculiarly fine flavor, but, because of the thickness of the rind or other faults, they fall short of the standard set for a market variety. In the future it is highly probable that seedlings will be produced which will have commercial merit, perhaps exceeding those of any introduced variety. There can be no doubt that the fruit, even of the seedlings, can be greatly improved by the best methods of cultivation. They respond freely to judicious care in fertilization and irrigation. The thickness of the rind and the amount of rag may be materially reduced by the liberal use of potash and the limited application of nitrogenous manures.

The following varieties are worthy of careful trial: Triumph, Duarte Seedling, Aurantium, Colton Terrace, Duncan, Marsh, Royal and Standard. The Triumph and Marsh or Marsh Seedless are reported as having done well in parts of Oahu, in the Territory of Hawaii. The distances between the trees need to be greater than in the case of oranges, because of the more vigorous growth made by the pomelo; 25 to 35 feet will be quite close enough on good soils. The fertilization, irrigation, tillage, picking, curing, and packing are essentially the same as described for oranges.

THE LIME.

The lime or acid lime (*Citrus medica acida*) is widely grown within the Tropics, but because of its extreme sensitiveness to low temperatures is not at all successful in many orange-growing districts. In Hawaii it thrives and produces large crops of fruit. It will prosper on rather rocky soils and those too poor for orange cultivation. The propagation is usually by means of seeds only, but budding has been practiced to a limited extent, and will doubtless be used more extensively in the future. Seeds can not be depended upon to reproduce exactly the same form as that of the fruit from which it was taken, but for many of the purposes for which limes have been used uniformity of shape, color, or size is not an essential. The trees should be planted 15 to 20 feet apart.

Limes are put to many uses. In the Tropics they are freely used as fresh fruit for the making of limeade and in the seasoning of foods. The market for the fruit in this form is increasing in the United States and the demands of the future for a lime of fine quality and appearance are likely to become so stringent that the better forms will be multiplied by budding. At the present time, however, by far the larger number of limes are marketed in the form of so-called secondary products. Considerable numbers of them are preserved in brine and sent to Northern markets. Larger quantities are used in the manufacture of lime juice and citric acid, while essential oil is extracted from the rind. The lime juice is obtained by pressing the fruits between rollers and is usually marketed in large containers. Citric acid is obtained from the concentrated juice, which is made by boiling down in open vessels.

Varieties.—Through prolonged seed propagation several more or less distinct types have been originated. In India, the home of the lime, several named varieties are known. In America, Hawaii, and the West Indian Archipelago the commonest type is that known as the Mexican or West Indian lime. Of this type there are many distinguishable forms, some of which are much larger and finer than the average. But few of them have been named, propagated by budding, and disseminated upon their merits.

Other varieties are the Persian and the Tahiti. The Tahiti is, in Florida, one of the most highly esteemed varieties of lime. The fruit is large, the rind of lemon-yellow color, the quality of juice excellent, and there are few seeds or none. The fruit is said to have a tendency to decay on the trees. In California this variety is not a success.—(Hawaii E. S. B. 9.)

PERSIMMONS.*

The Persimmon or Date Plum (*Diospyrus Virginiana, L.*) belongs to the order Ebenaceæ, which is so named in consequence of several species of this genus yielding the black wood called ebony. It is a native of North America, and is found growing wild in most of the Southern States, where it produces fruit in the greatest abundance. It is one of the wild fruits of the United States which has received but little attention, although it possesses many desirable qualities which when brought to a higher state of perfection by selection and cross fertilization will undoubtedly cause it to be more highly appreciated by the farmer and the horticulturist. Since new methods of propagation and cultivation are being introduced in its culture, so that new trees frequently begin bearing at from three to five years from the bud or graft, it is believed that this fruit is capable of being improved to such an extent as to make it of commercial importance equal to that of some of the Japanese varieties.

Culture.—The persimmon is similar to the peach and plum in its choice of soil and location, but it will grow well on almost any kind of soil, from rich bottom land to poor thin soil of the hilltops. However, a warm soil well exposed to the sun is the best. The persimmon is readily propagated from seed. The seedlings, however, especially from cultivated varieties, cannot be depended upon to reproduce themselves. In fact this fruit varies greatly in the wild state. Twenty trees raised from the seeds of one parent tree may produce twenty distinct varieties; therefore resort must be had to budding or grafting the young stocks with buds or scions from the variety which it is desired to propagate. A desirable seedling variety may be multiplied by breaking up the roots of the parent tree, thus causing it to throw up sprouts or suckers. These, however, are difficult to transplant successfully owing to a deficiency of root development.

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* **For illustration, see page 465.**

Time to Bud.—Both budding and grafting should be done in the spring. Fall budding has proved a failure on account of the flow of sap which prevents the adherence of the bud to the stock, but the operation may be readily performed in the spring as soon as the bark will slip freely. This operation may be as easily and successfully performed on a persimmon tree as it can be on an apple tree. Many farmers have growing on their farms trees which are either barren or which bear inferior fruit. By top-working such trees with improved varieties, they may soon be transformed into trees of great value. In working over such trees the grafting should be done in the younger and more vigorous branches. Scions should not be inserted into large branches, but these should be cut off and allowed to throw out several strong, thrifty shoots which may be grafted the second season. The surplus shoots may then be removed.

Transplanting.—The persimmon is more difficult to transplant successfully than almost any other kind of fruit tree. The tree has a long center or tap root, and if too much of this root is cut off in transplanting, the tree will die. The safest plan is to secure quite young trees, one or two years from the graft being preferable. Older trees may be successfully planted if they have been transplanted once or twice while growing in the nursery. The soil where the trees are to be transplanted should be thoroughly pulverized with a subsoil plow to a depth of at least eight inches below the bottom roots, so that an abundance of moisture may be supplied to the young growing roots during the first season.

Transplanting is most successfully done in autumn, as the tree then becomes adjusted to its place by spring, and the roots, if properly pruned before planting, will be nicely calloused and ready to throw out their fibrous rootlets as soon as the warm days of spring appear.

The persimmon may be greatly improved by cultivation. It is especially necessary that the trees be well cultivated for the first few years after planting until they become adapted to their new surroundings. The trees will stand a great deal of neglect when once well started, but should not be subjected to such treatment if one expects to secure the best results. In the wild state the trees will thrive on very thin land, and under seemingly discouraging circumstances, and still bear fruit of very good quality, but the largest and best fruit is only produced when the trees are kept in a perfectly healthy condition by cultivation.

Varieties.—Almost every tree is a variety of itself, as the persimmon, like the apple, does not reproduce itself from seed with certainty. In the wild state it is sometimes found growing in clusters of ten or a dozen trees, and all apparently of the same variety, but these probably came from the roots of the original or parent tree.

The fruit differs in size from that of a small wild plum to that of the large cultivated kinds, an inch and a half to two inches in diameter. They also vary greatly in form; some are globular, others either conical or oblong, those of the globular form predominating. The following are some of the varieties: Shoto, Early Bearing, Golden Gem, Daniel Boone, Hicks, Kansas, Early Golden, and Smeech, a seedless variety originating in Tennessee.

Handling the Fruit.—The persimmon is not as perishable as some suppose; it can be kept for several months. The fruits seldom rot, but dry up, and in this condition they have been kept till March and April by simply keeping them in a cool dry place. They keep better, however, by packing them away in sugar in a jar or other tight vessel. They may also be canned by simply placing the clean, ripe fruit in a glass jar and pouring over it a syrup made of granulated sugar and water. It is not necessary to heat the fruit before canning. They may be used as occasion demands for making puddings, etc.

The long-keeping qualities of this fruit enables the grower to ship his fruit to distant markets without fear of loss from decay. Besides this, there are many other points favoring the introduction of the persimmon as a commercial fruit. First, the people are beginning to appreciate it, and this will soon create a demand for it. Like all other kinds of fruit, however, in order to create a demand for large quantities, it is absolutely essential that nothing but the choicest varieties be placed upon the market, and these in an attractive form. A few crates of small, seedy, astringent fruit would very quickly destroy the best of markets. The fruit is easily handled and good fruit will bring good prices in the markets. Again, this fruit is almost entirely free from the attacks of insects and fungi, and a failure to produce a crop is a very rare occurrence, as the blossoms seldom open till all danger of frost is past.

The best varieties are early and continuous bearers, but there is still an opportunity for improvement in quality and size. When, by careful cultivation and propagation, these qualities have been brought to a sufficiently high standard, then it can be expected that the persimmon will occupy an important place among the cultivated fruits.—(Ind. E. S. B. 60.)

The Japanese Persimmon.—The people of Japan regard their native persimmon as their most valuable fruit. Chemical analysis has shown that the persimmon has a high nutritive value. In most respects the Japanese persimmons are similar to the ones of the United States. The soil requirements and method of propagation and cultivation are essentially the same. The Japanese persimmon is not as hardy in the United States as the native species, but will probably become so after continued grafting on native stock.

The tree of the Japanese persimmon varies a great deal in size and shape. In Japan, the wild tree often attains a height of from 40 to 50 feet. Under cultivation the tree is considerably smaller and has a more spreading habit than that of the wild one. Heavy bearing, while the tree is young, also dwarfs it to a great extent. No fruit varies more than the Japanese persimmon in form, size, color, flesh, flavor, color of flesh, number and form of seeds, texture and thickness of skin.

In form they are round, quadrangular, slightly or strongly oblate, oblong, conical, strongly pointed, or a combination of two or more of these forms. In size they vary from one and one-half by one and three-fourths to three and three-fourths by three and one-half inches. In weight from a few ounces, as Zengi, to over a pound, as some specimens of Hachiya and Tanenashi. The Japanese persimmon is now widely cultivated to a greater or less extent throughout most of the Southern United States and in parts of California. In the Southern States the area adapted to its culture corresponds in a certain measure with the cotton belt.

Marketing.—The fruit should be gathered when it is fully matured and before it softens. It must be carefully handled so that the rind is not injured and it should not be poured from one receptacle to another, but handled entirely with the hands. It must be cut from the trees, and for this purpose the best instrument is a pair of ordinary orange clippers. All injured or bruised specimens should be discarded.

If the fruit is to be delivered to the home market it is preferable that it be allowed to become quite or nearly matured on the trees. In Florida difficulty is usually encountered in allowing it to ripen on the trees as the mocking birds are extremely fond of the fruit. In view of this fact, the better plan is to remove the fruit from the trees when fully matured and just before it begins to soften. Place it in a dry, warm room and allow it to ripen. The flavor will be quite as good as when ripened on the trees.

The best package for shipping the Kaki is the six-basket carrier, commonly used for tomatoes and peaches. The fruit should be wrapped, the wrapper being of the best quality, as it is likely to be torn by the small, sharp, nipple-like point at the apex of the fruit. In placing them in the baskets they must be put in in regular order and each basket in the carrier should contain exactly the same number of fruits. The first row should be put in with the base downward and if three layers are required to fill the basket, the second one should be reversed, while the third layer should be placed with apices upperward. The fruit should project about one-half inch above the sides of the baskets. If the fruit is to be sent into a new market, it will be a good idea to place in each basket a small placard giving the name of the fruit and stating how and at what stage of ripeness it should be eaten. This will in some measure prevent attempts at eating it before it is fully ripe and hence create a more favorable impression of the fruit.

Some of the California shipments of Japanese persimmons to the Eastern markets have been made in box carriers containing a number of trays in which the fruit is placed in single layers. This seems to be an excellent method for shipping them and when opened on the market, they show up in inviting shape.—(Ind. E. S. B. 60; Tenn. E. S. B. 1, Vol. XI.; Fla. E. S. B. 71.)

PINEAPPLE GROWING.

It has been demonstrated repeatedly that even a willing laborer may become a pineapple grower. The absolute outlay in money may be reduced to the cost of the plants, the cost of the fertilizer, and the cost of land. This puts the cost for the first year at about $50, and to carry this forward to the ripening of the first crop about $20 more should be added, making an outlay of $70 to produce the first crop on an acre. In the pineapple-growing section of Florida there is sufficient demand for labor to more than keep a man while he is growing his first crop. Another plan adopted is for two persons to form a partnership, one working to supply the needed cash while the other grows the crop of pineapples. After the first crop has been produced the increase in the number of plants will permit the extension of the area as rapidly as financial conditions will allow. The one great drawback to the average man's succeeding in pineapple growing is that the returns come in at one time and during a short period. So it is a case of labor and wait for about eleven months in the year for the returns during the twelfth month. The character of the pineapple land does not permit many other crops to be grown upon it successfully; consequently the greater number of pineapple growers have to depend on this crop alone.—(F. B. 140.)

The Pineapple Family.—This plant belongs to a very peculiar family, the Bromeliaceae, and is the most important species in the genus Ananas. In its original distribution the family was confined to the Western Hemisphere, mainly to South America, though the genus Tillandsia is represented by a number of species in the Southern States. As a whole, the family is either tropical or subtropical. The long moss, or Spanish moss (*Tillandsia usneoides* L.), is a peculiar plant common along the eastern Gulf and south Atlantic coast. This species of the pineapple family grows abundantly in the moister localities of the above region and is largely employed in that section for making mattresses and stuffing furniture.

This family is characterized by plants of an epiphytic nature; that is, those that grow on other plants but do not derive nourishment from them; but many of the species are terrestrial in their habits. In Florida they are frequently spoken of as orchids; doubtless due to the popular belief that all epiphytes are orchids, which is incorrect. The pineapple plant is terrestrial but might be looked upon as half epiphyte in that it will remain alive for months without being in contact with the soil. In contact with moist, loamy soil it soon sickens and dies.

It takes about four months from the time of blossoming to the ripening of the pineapple. The main season of blooming is during January and February, though occasionally plants bloom through the entire year, the least number occurring in November and December.

Immediately preceding the bloom a number of bright-colored leaves are produced as if to announce its advent. The blossoms proper occur in a head springing from the center of the plant. Their color is usually a purplish blue, though there is some variation even in the same variety. The blossoms though crowded into a head are quite distinct, each having its own insertion on the central axis. Each blossom is protected by a bract. The crown does not develop until later and its development does not depend upon the bearing of fruit.

Treating Chestnut Poles with Open Tank Method. Dept. of Agr.
(See pages 397-404.)

A Small Commercial Greenhouse. Dept. of Agr.
(See page 510.)

The production of seeds in this fruit is rather the exception than the rule. Some varieties produce more seeds than others. While many of the species of this family have their seeds provided with a pappus of down for transportation, the pineapple seems to secure its dissemination by means of the fleshy edible fruit.—(F. B. 140.)

Varieties.—Red Spanish or Scarlet. Flesh white, rather fibrous and tart; weight 1½ to five pounds; flavor good; shape shouldered; good shipper; grown in greater numbers than any other variety probably because the plants can be easily procured. Considered by some the best all-around pine. Fairly prolific in slips and suckers. Sugar Loaf. Flesh white, very sweet and tender; fine table fruit; poor shipper; shape conical; weight 1½ to four pounds; smooth. Sells well in local market. Fruit often rots on the plant before fully ripe. Prolific in slips but not in suckers. Black Jamaica. Flesh white, very tender and juicy, finest flavor, weight two to six pounds; shape columnar; very smooth; good shipper. Prolific in slips and suckers. Prickly Cayenne. Flesh yellow, tender, good flavor; shape shouldered and conical; fruit sometimes larger at apex than at stem end; good shipper; smooth; weight three to six pounds. Prolific in slips and suckers. Plant broad leaved and vigorous. Smooth Cayenne. Flesh yellow, tender; flavor fine, very juicy; shape shouldered; very smooth; good shipper; weight three to nine pounds. Prolific in suckers, but not in slips; we only had two slips from 100 plants. This no doubt is the most popular variety grown, owing to the fine appearance of its fruit, and the smoothness of its foliage, making the plants very pleasant to work among. The leaves of all other varieties are very spiny on the edges. Enville, or Enville City. Flesh white, tender, juicy; flavor good; shope conical, flattened at apex; multiple crown; rough; good shipper; weight, three to ten pounds. Prolific in crownlets, slips, and suckers. The misshapen fruits, and the tendency to rot before fully ripe, form an objection with many. A number of specimens will be seen with single crowns, and the fruit of symmetrical form, and this tendency may become a fixed characteristic by selection, and so render the variety more valuable. The tendency of the fruit to rot before reaching full maturity, may be overcome to some extent by judicious manuring, avoiding the application of highly nitrogenous manures during fruiting season. Abbaka. Flesh yellow, tender, very juicy, fine flavor; shape, shouldered; smooth; good shipper; weight three to ten pounds; prolific in slips and crownlets, but few suckers. This variety will yield a greater increase of plants than any of the plants grown at this station. Some of our Abbakas yielded this season as high as thirty plants; they averaged twelve plants apiece. A popular variety. Golden Queen. Flesh yellow, very tender and juicy; flavor good; shape columnar; good shipper; rough. A favorite with many. Prolific in both slips and suckers. Prince Albert. Flesh light yellow, tender and juicy; flavor fair; weight two to six pounds; rough. Prolific in slips and suckers. Porto Rico. Flesh light yellow, tender and juicy; flavor good; shape shouldered; good shipper; weight four to fifteen pounds;

smooth. This variety is immensely popular on the East coast.—(Fla. E. S. B. 37.)

Climate.—The culture of this crop should not be attempted in a latitude where winter frosts occur unless one is prepared to provide the proper protection. Neither does the pineapple flourish in the extremely hot portions of the globe. Its largest acreage is confined to the islands or to the seacoast. The best pineapple region in the world has a mean temperature of from 75° to 80°. Key West, off the coast of Florida, has a mean annual temperature of about 76°; Jupiter, in the midst of the pineapple region, about 73°. The mean annual temperature in a large part of the pineapple section of Florida is thus comparatively low.

Soil.—The proper selection of soil for pineapples is the most important problem in connection with their culture. The requirements of this plant in this respect are so different from the ordinary fruits that it took many experiments to convince the would-be pineapple grower that he has here a plant that demands a soil utterly intolerable to the ordinary crops of vegetables. This crop can be grown upon land that will produce ordinary vegetables, but the soil must be of a loose and open nature and not allowed to become water-soaked. It is not the fertility nor the humus in the soil that is detrimental to the pineapple, but it is the want of free drainage.

The soil prepared by the gardeners who grow this crop under glass illustrates this point. Their standard formula is about as follows: Two parts decomposed fibrous loam, one part well-decayed manure, another part one-half inch bones and pounded oyster shells. From this it is seen that even where the control over temperature and moisture is the most perfect the texture of the favorite soil is open and decidedly loose. The directions for watering are fully as interesting: "Moderately in winter and freely in summer."

After the field has been thoroughly cleared it is laid off into lands of widths to suit the purposes of the planter. A favorite distance, where the field is extensive, is to lay the lands off about 60 feet wide. This leaves a distance of about 30 feet for the man who breaks the fruit to toss it to the man in the pathway—one side of a land being picked over at a time.

The lands are laid off in varying checks, favorite distances being 18 by 18 to 22 by 22 inches for the smaller varieties, 22 by 22 to 30 by 30 inches for the medium sized, and from 30 by 30 to 48 by 48 inches for the largest varieties, or the distance between the rows may be greater than that between the plants in the row. A favorite distance for Red Spanish is 18 by 22. Smooth Cayennes are often planted 20 by 30 inches apart.

The method of planting in beds about 15 feet wide under sheds has been practiced for a considerable time and is gaining in favor. This allows the laborers to use the shuffle hoe without going between the plants, and also to apply the fertilizer by merely stepping among the plants of the first two rows. It is always necessary to exercise the greatest care in order to avoid breaking the leaves. On the

Florida Keys the laying off of lands is impracticable, but plants must be set wherever there is room and enough soil.

When the planter has determined the size of his lands and the distance between the plants in the row and the distance between the rows, the rows and checks are laid off either by hand or by a horse marker. It is not worth the while to exercise great care to have the rows exactly straight nor the plants placed at mathematical distances. If the soil be somewhat firm the rows may be opened with a small plow. Various other methods are adopted to meet the needs of the individual field. In planting under sheds the lands, or beds, are laid off so as to leave the roads and ways free from posts, the beds being made as wide as the greatest distance between the posts, with the rows of posts running down the middle of the beds. The location of the roads will depend upon the needs of the individual sheds.

Planting.—Suckers are planted for the main crop of the common varieties. Slips and crowns take too long to mature a crop to be utilized excepting when suckers are not to be obtained. Well-matured suckers will produce a crop in fourteen to eighteen months from time of setting out.

The sucker should be set 3 to 5 inches deep, according to size, care being taken not to set it so deep that sand can be easily blown into the bud. Many planters prefer to clip off the ends of the leaves to keep the wind from blowing the plants over. This is not necessary except in exposed fields and should be avoided if practicable.

Crowns are not utilized extensively for planting because they are shipped with the fruit and it requires a year longer for them than for suckers to come into bearing. In the vicinity of canneries they might be used, but as a rule they are not worth the cost of saving. They are set out just as suckers are, but there is less danger from sanding and from being blown over.

Slips are usually so small that they are used only in the higher-priced varieties, or when plants are scarce. They are treated very much as the sucker, but need much more attention and care. They can not be set more than 2 to 4 inches deep, and even then there is danger of their sanding or being blown over. It usually takes slips a year longer to mature a crop than it does well-matured suckers, though large slips planted at the right time may mature a crop in twenty months. Seed is used only for experimental purposes, like originating new varieties. It is said to take these ten or twelve years to mature a crop.

Time of Planting.—Plants may be set out at any time during the year, but the favorite time is during the fall after the suckers have made a good growth and are somewhat hardened off. If set at this time of the year they will make considerable growth during the fall months and early winter. If set at the beginning of winter a considerable per cent may be lost from various causes.

If there should be suckers fit to set out during the spring the pineapple grower should not permit any avoidable disturbance at that time, because it is the time of fruiting, when the plants need every advantage possible to produce the finest fruit. Practically the time for setting out pineapple suckers is limited to the season from July to November, and in a more limited way to the 1st of February.—(F. B. 140.)

Fertilizers.—The pineapple is a voracious feeder. It requires heavy fertilizing. Nitrogen, phosphoric acid and potash are all required in generous amounts. Perhaps the following manures are the best sources from which to obtain these requirements: Poultry manure, stable manure, guano, blood and bone, bone meal, cottonseed meal, acid phosphate, sulphate of potash, and well-rotted muck. If compost is used, it should be well-rotted and ready for assimilation. Compost, undergoing fermentation, will destroy the feeder roots. Lands containing much silica and vegetable mould, are the best for this fruit, especially if there is a good foundation to prevent leaching away of fertilizers and moisture.

Cultivation.—Clean cultivating is best, with a scuffle hoe, being careful not to cut the feeder roots, which are found one to two inches below the surface. Mulching is often a disadvantage, for while the mulched plants are green and thrifty, they are too susceptible to frost. If planted in well pulverized rich soil, 18 by 18 inches, the plants will protect each other, and prevent the fruit from falling over to get sun-burned.

When planted close together, the leaves stand more erect, and become a partial shade for the fruit during a part of the day, which is an advantage. If set close together, they only require cultivating the first year, as the plants monopolize the ground and keep other vegetation down when one year old. It has been found that pineapples are just as large from plants set 18 inches by 18 inches as from plants set four feet each way. Plant closer rather than farther apart. With the pineapple, as with everything else, the less injury to the foliage the better. In cultivating, step on top of the leaves, as bending them down does no great amount of harm, while striking a leaf sideways is likely to tear it loose and injure the stalk. In fertilizing a plat, mix the fertilizers well and sow over the plants, like sowing oats broadcast, and let the dew and rains dissolve and carry it down.—(Fla. E. S. B. 27.)

Gathering.—It is not an unusual experience for the agriculturist to do all that is necessary to bring a crop to excellent maturity and lose it all or in part for the want of proper handling at the time of gathering. In no line of work is it more necessary to pay the close attention to details in gathering than in growing tropical fruits. This operation is the one most directly under control, and yet it is the one most liable to be slighted. It is the operation in which judgment plays the most important part. It cannot be learned except by experience.

Selecting.—The fruit should be dry when gathered. The first act in gathering is to select the fruits thought to be ripe enough to reach the market in the best condition. This is done by a laborer under the direct supervision of some responsible person who from time to time instructs him as to whether to select more mature or less mature specimens. The degree of maturity will depend upon the market to which the product is to be shipped and to the manner of shipping, whether by express, freight, or by water. In the summer, if the fruit is to go forward as freight it is selected when it is "just turning." If it is to go by water it is selected a little less mature, and if by express the fruit may be permitted to become "quite well colored." The matter of selecting depends so much on judgment that no fast rule can be laid down. The distance from the market, the condition of the weather, and the variety planted are all factors which must be considered.

Care in Handling.—Handling begins when the laborer has seized the fruit to be broken, and ends, so far as the grower is concerned, when the fruit is on the railway platform or on the steamboat dock. The laborer who goes among the fruit is usually provided with a pair of leggings that reach above the knees and a pair of mittens made of canvas.

He seizes the pineapple usually in both hands, and gives it a slight twisting bend to cause the stem to snap off a half inch or so below the fruit. "Breaking pines" requires skill and attention. If the stem be broken off too near to the fruit it is apt to rot in transit, and if the stem is broken too long it has to be broken again at the shed at a loss of considerable time. Only the more intelligent and better laborers are sent into the land to break or to cut pines. After breaking, the pineapples are tossed to a laborer standing in the pathway between the beds, who catches them and lays them down carefully. From this place they are collected in large baskets or in field crates and hauled to the packing shed.—(F. B. 140.)

Marketing.—If the fruit can be sold at a fair figure at the packing house, it is usually best to take it. Then someone else than the grower has to assume the responsibility of market fluctuations and delays in transportations. Frequently the crop is sold in advance at a certain fixed rate per crate. Such contracts usually cover the fruit harvested within a certain period. The private trade in pineapples has assumed considerable proportions. To the larger grower this method of marketing pineapples is not very inviting owing to the extra amount of time and care required. But it is worthy the serious consideration of the small grower.

The fruit supplied to a private trade should be of the best quality, carefully selected, neatly and tastefully packed. In dealing with private customers every effort should be made to give the same grade of fruit in every order. Uniformity is absolutely necessary in holding the good will and confidence of a private customer. All packages for the private trade must usually go forward by express.

The bulk of the pineapple crop is handled either directly or indirectly by the commission merchants. The main objection to the commission merchant system of selling fruit, is that the grower has to place himself entirely in his hands. There seems, however, no way of overcoming this objection. There are honest men in the commission business, as large a proportion as in any other line of endeavor, and there are always ways and means of finding out which are the honest, responsible houses and which are not. Select a good house and stick to it.

In shipping to commission merchants, the best policy is to select one reliable man in each market to which shipments are to be made and ship to him alone. Do not split a shipment in any one market, sending part of it to one man, part to another. It is not fair to the merchant and will result in loss to the shipper. Try to work with the commission man. If he wants riper fruit, send it to him; if not so ripe, let him have it. He knows the market as the grower cannot. Try to give him what he wants.

OLIVE CULTURE.

Cultivation.—The olive is a native of southern Europe, and has been cultivated in nearly all the countries surrounding the Mediterranean from time immemorial. From there it has spread to various countries which offer, like California and the arid Southwest, similar climatic conditions. It requires an average yearly temperature somewhat higher than is required by the vine, and will not withstand so low a temperature as the latter. It is dangerous to plant olive trees in any region where the temperature often falls below 20° F. Some varieties will withstand 15° F., but only for a short time; and the young wood of many varieties is injured even above this temperature. At 10° F. the whole tree is destroyed. In spring, after the new growth has started, much less cold than the above is harmful. On account of its need of an even climate the olive is seldom cultivated successfully more than one hundred miles from the sea, and succeeds best where the mean temperature of the coldest month does not fall below 43° F.

The olive needs a light, well-drained soil, and either does not succeed, or gives fruit of poor quality, on heavy, clayey, or ill-drained soils. It is especially suited to sandy or loam soils rich in lime, and will grow in soils so rocky that nothing else but a vine could succeed in them. It is a mistake, however, to suppose that the olive will give profitable crops in poor soils; such soils must be well fertilized to insure good growth of the young trees and good crops on the old.

The olive requires less water than many cultivated trees, on account of its light foliage, and of its strong root-system, which penetrates to a great depth even in very rocky subsoils, if well drained. It is a great mistake, however, to suppose that an olive tree will produce profitable crops in a dry soil. Failure to give sufficient water and cultivation to both young and old trees is responsible for the lack of success in many thousands of acres of olives. Where the rainfall is very light, however, irrigation is necessary. It must not be excessive, and the water level must be kept low, otherwise the quality of the crop will be inferior and the trees more subject to disease.

Olives are generally propagated by cuttings. There are several different methods, but the following probably gives the best results: Young shoots, several inches long, are cut from strong, vigorous trees with a sharp knife. They should be cut as soon as their wood is fairly well hardened, but not too late in the season; and all the leaves should be removed, except two or three at the top. They should be planted immediately in shallow boxes of sand, placed in a greenhouse or a warm shady place and kept moderately moist. In three or four months most of them will be well rooted, and should be transplanted to pots or to a nursery where they will receive more sun. Here they should remain for three or four months longer, and are then ready to be planted in place. It is best not to plant them too early in the spring, before the soil has been well warmed; and care must be taken during the first year that they do not dry out.

An olive orchard may be brought into bearing a year earlier by using larger cuttings of old wood, but the trees are seldom so strong and are much more uneven than by the foregoing method. The cuttings or truncheons in this case, in California, are taken in December or January, from branches two or three inches thick, and are cut about twenty to thirty inches long. They should be made only from strong healthy wood with sound bark. They should be cut so that they have knots at the base, as this favors the production of roots. Great care should be taken not to bruise them, and all the shoots should be removed except a few at the top. They should then be planted in a nursery of very light sandy soil, being buried about two-thirds of their length and the soil tightly packed around them. The top ends of the cuttings should be coated with pitch, and if the weather is hot or dry, the nursery should be shaded until the cuttings begin to throw out shoots. A very thorough watering should be given the ground immediately after planting, and the soil must never be allowed to get dry until the cuttings are well rooted. A certain portion of the cuttings will fail to grow with the best of care, and many will remain dormant for one or two years. Those which grow well, however, are ready for planting-out in the orchard the following season.

Another method commonly practiced is to cut sections of large branches one or two feet long, split them in two and then to bury the halves horizontally, with the bark up, about three inches deep in the nursery. If the soil of the nursery is warm, light, and well drained, and kept rather moist, a large number of shoots will in a few months start from the buried sections and come through the soil. When these shoots have become firm, but are still growing, they are cut off, with a sharp knife, as close as possible to the old wood and planted in the same manner as described above for the young shoots taken directly from the trees.

One of the commonest methods of propagation, used especially in Italy, is by means of "uovoli." This is the name given to the knot-like swellings that occur very plentifully on the trunk of many varieties, especially near the base, and on the exposed parts of the main roots. They are masses of dormant buds, and receive their name from their resemblance in shape, after removal, to eggs. They should be cut out carefully, and the places from which they are removed painted over with pitch. They are generally removed in November, and in frostless localities may be planted immediately.

If necessary, they may be kept for three or four months in a dark cool place, buried in sand and planted in the nursery when danger of frost is past. The "uovoli" are planted three or four inches deep in a sandy soil, and of the many shoots which start from each, only the strongest is allowed to grow. They are ready to plant out in place in two or three years. This method of propagation, at one time common, is being gradually abandoned as, besides injuring the trees from which the "uovoli" are taken, it results in poorly rooted, short-lived trees, which are inordinately prone to produce suckers.

The strongest, heaviest-bearing, and longest-lived trees are those grown from seed. Seedlings have a stronger and more deep-seated root-system, and grow into more regular and more hardy trees than those grown from cuttings. The only objection to their use is that they require several years longer time before commencing to bear. With care and intelligent cultivation, however, this delay can be reduced to one or two years, and the larger crops and healthier trees resulting, will more than compensate ultimately for the loss of time.

The flesh of the olive should be removed before planting the pits. This is commonly done by piling the fruit in heaps and allowing it to decay, after which the pits can be easily removed by washing. Many of the seeds of most varieties will not germinate. These are separated by placing all the pits in water and rejecting those which float. The pits may be planted immediately, or if there is danger of frost, kept in dry sand until spring. The pits must be cracked before sowing, or they will remain two years in the ground before germinating. This must be done very carefully, in order not to injure the kernel; special instruments have been made for this purpose, which work well. Instead of cracking the pits they may be placed for twenty-four hours in a lye solution containing half a pound of caustic soda to one gallon of water. This softens the shell so that it soon decays in the soil and allows the young seedling to push through. The pits, after cracking or softening, should then be sown in a sandy bed heavily fertilized with thoroughly rotted manure. They are placed every three inches in little drills which are made six inches apart. Enough well-rotted manure should be placed in the drills to cover and surround the pits, and the whole covered with soil to the depth of one inch. The beds should be well watered until the seedlings start; after which less water should be used. When the seedlings have developed five or six leaves they should be transplanted to the nursery, the roots at the same time being cut back to about half their length. The olive, like all evergreen trees, is likely to suffer from transplanting, unless care is taken to remove the young plant with an adhering ball of earth. This is facilitated by the manure which is placed around the seed when planted.

The seedling always revert more or less to the wild plant or type, so that it is necessary to graft or bud them with the variety which it is desired to propagate. This may, in very favorable cases, be done the spring after planting, but usually they are not large enough until after the second spring. Two-year-old wood should be used for grafting, and the grafts put in at the neck of the roots, just below the surface of the ground.

The ordinary wedge-graft is usually used, and the union should be carefully tied up and covered with grafting wax. The soil is then piled up around the graft until only two eyes are exposed. If the seedlings are large and have thick bark they may be budded in the stem just above the ground.

Transplanting, and Care of Young Trees.—It is customary in most olive-growing countries to keep the young trees in the nursery for several years—from four to twelve and even fourteen years, the average being about seven. This long sojourn in the nursery has two objects: First, as the olive can be transplanted at almost any age, the older trees run less risk of failing to grow than the very small ones if proper cultivation or irrigation should be neglected; and, second, because when large trees are put out in the orchard they come into bearing several years earlier than when small ones are used, and so several years of cultivation of the orchard are saved. On the other hand, it should not be forgotten that the olive is no exception to the general rule that the younger a tree is when it is planted in its permanent place, the better and stronger will be the root system which it develops, and consequently the more vigorous and long lived the tree. Trees two or three years old can be planted out with perfect success, providing they are given careful cultivation for the first few years and watered and manured when necessary.

For the first four or five years, whether the young trees are planted out or left in the nursery, great care should be taken to prevent them growing into an undesirable shape. They should be well staked to keep them vertical, and the lateral shoots from the lower part of the stem should be removed when young, in order to avoid the necessity of making large wounds later. In cutting off these lateral shoots the cuts should not be made too close and the leaves at their bases should be left, as they help to feed the plant and protect the stem.

Pruning.—Though olive trees are grown in some districts without pruning, there can be no doubt that intelligent pruning increases the regularity, quantity, and quality of the crop. Heavy pruning at intervals of several years is practiced very commonly, but results in irregular bearing and renders the trees more susceptible to disease. The system which gives the best results from all points of view is a moderate pruning every year. Two main objects should be kept in view in pruning: 1. To give the tree the most convenient form; 2. To cause it to produce as large a crop each year as is consistent with the quality of the fruit and the health of the tree.

For the smallest-growing varieties the tree should branch out about three feet from the soil, and should be given a spherical, bush-like top. For the stronger and larger growers the trunk should be four or five feet high, and the branches should grow in "goblet" form. The object is to give every part of the tree, as nearly as possible, an equal amount of air and light, and to give it the form that best facilitates gathering the crop. It should always be kept in mind that any part that is unduly shaded will fail to produce fruit.

All the fruit of the olive is borne on two-year-old wood, and the same wood never bears twice. That is, the crop of this year is borne on the shoots that grew last year, and the next year's crop will be borne on the shoots that develop this year. For this reason a new crop of shoots each year is essential to regular bearing.

The art of pruning can be learned only by practice and experience; but it will be found useful to keep the following points in mind: Cut away all dead or diseased twigs or branches; thin out wherever the branches are too close; cut back the branches that tend to grow too long, in order to make them send out side shoots for fruiting wood. It should also be kept in mind that heavy pruning confines the sap to fewer outlets, and results in the production of vigorous sterile or wood-bearing shoots; while light pruning, leaving a larger number of buds, results in a large number of weaker and more fertile shoots. A tree, therefore, which has sent out an inordinate number of sterile shoots, should not be cut back much; while a tree that has been enfeebled by any cause must be more heavily pruned.

When a tree has been properly pruned from the beginning, it is seldom necessary to remove anything but small twigs, or to make large wounds. When, however, on account of improper pruning, or of great age of the tree, all the main branches of the tree have become bare, and all the fruit-bearing wood has disappeared from the center of the tree, it is necessary to cut back even the largest branches. This, however, should be done gradually, or the tree will be injured by a too sudden curtailment of the leaves, which are its feeding organs. A heavy pruning should be given the first year, sufficient to force out shoots from the lower parts of the branches. The next year the most vigorous and best situated of these shoots should be chosen to replace the old branches, and the latter cut back still further. A branch of any size should not be cut back too close to the old wood, even when it is intended to suppress it completely, as there is danger of injury to the main branches or trunk by drying out of the wood. Whenever a large cut is made, for any reason, it should be painted over with pitch or some similar substance, to diminish evaporation and to prevent the growth of fungi.

Grafting and Budding.—It has already been stated that when an olive tree is raised from seed, it reverts more or less to the wild form, and produces fruit which is generally unsuited for either oil-making or pickling. To have the desired quality of fruit, therefore, it must be grafted or budded with a better variety. The method of doing this with young trees has already been described under the head of propagation. The olive may be grafted by almost any of the methods used for other fruit trees; but they are not to be recommended except when, as in the case of young seedlings, the graft can be made below the surface of the ground. For large trees, when it is desired to change the variety, budding is to be preferred.

Budding succeeds well if done at the right time and under the proper conditions. The essential points are that the bud must be taken from good healthy wood, and inserted in a vigorous shoot. Most of the failures in budding result from using a shoot of low vitality as a stock. In order to insure shoots of sufficient vigor to start a bud, the tree which is to be budded should be pruned severely the year before. If the tree is large it is advisable to cut back only half the branches the first year. The following spring the pruned branches will send out a number of vigorous shoots, the best of which may be budded. The following winter the rest of the branches should be cut back and the budding completed the second summer. In this way the tree does not receive so rude a shock as if all the branches were cut back the same year.

The ordinary T-bud succeeds very well on the olive, though some prefer the shield-bud. For the scion a dormant bud in the axil of a leaf may be taken, as is usually done for other plants. With the olive, however, twig-buds are more successful. The twig-bud must be cut deeply with a sharp knife and part of the wood removed before insertion in the stock. Also about two-thirds of each leaf on the twig-bud should be cut off to prevent drying out by too much evaporation. The bud is inserted in the usual way and tied by winding a cotton string tightly around the stock, both above and below the bud, so as to cover up all the cut parts. Three or four weeks later the string should be removed and the stock topped. If the union has been effected the bud can be left to itself, simply cutting off the whole of the stock above the bud as soon as the latter has developed sufficient leaves. Budding may be done at any time when the sap is flowing freely, but is most successful if done in the early summer or spring. If done too late the buds fail to start until the following spring, and are apt to dry out.

Gathering the Fruit.—Whether olives are to be used for pickling or oil-making, it is very important that they should be picked carefully and at the right time. For green pickles they should be picked very soon after they obtain full size, but before they have begun to color or soften.

For ripe pickles they should be gathered at the same stage of ripeness as for oil-making; that is, when they contain the maximum amount of oil. This is soon after they are well colored, but before they have attained the deep black which signifies over-ripeness. If the olives are gathered too green the oil will be bitter; if too ripe, it will be rancid. On account of the different degrees of color in different varieties of olives, it is difficult to tell from their appearance when they should be gathered. When they can be easily shaken from the tree they are ripe enough. If they commence to fall without vigorous shaking they are over-ripe. For whatever purpose the olives are to be used they should be carefully gathered by hand. Rakes or sticks should never be used, as they bruise the fruit and break off a great deal of the fruit-shoots needed for the following year. It is well to sort the olives as they are being picked, separating out the bruised, diseased, or under-ripe fruit. When the olives are for oil-making they should be washed before being crushed or dried, unless they are very clean, for the road dust and sooty mold that often covers them have a deleterious effect on the quality of the oil.—(Calif. E. S. B. 123.)

Yields.—The age at which olive trees come into bearing varies with the variety. In general, however, if the trees have been well cared for, they will bear a few scattering fruits during their fourth and fifth years. When they are seven years old the crop should amount to several gallons per tree. After the age of ten years has been reached, the trees should yield an average of one hundrd pounds per tree, or from three to four tons per acre. Large old trees may occasionally yield seven or eight hundred pounds at one picking. Such a large crop is almost sure to be followed by a light crop the succeeding year. Very heavy crops of olives are undesirable, because the fruits are small and thus the total percentage of pits to bulk of crop is much larger. Olive wood is brittle and the branches are prone to break to pieces under a very heavy load. For these reasons, olive growers should strive by systematic annual pruning to cause the trees to bear a medium load of very fine large olives every year. On account of the labor involved, it is doubtful if thinning the fruit by hand can be done with profit, except perhaps in the case of the very large fruited varieties used in making high grade pickles.

The Outlook for Olive Products.—The consumption of olive products in the United States is far in excess of the production, although there are facilities in this country for growing an amount of olives greatly exceeding the consumption. There are two chief reasons for this state of affairs. In the first place the wages paid for the labor necessary in the production of olives is approximately three times as much in the United States as in the olive growing countries of Europe and Northern Africa. This difference in the cost of production of raw material also applies to many other items in connection with the manufacture of olive products. It therefore follows that in spite of the duty on imported olives, the competition of European growers is keenly felt in this country.—(Ariz. E. S. B. 62.)

THE DATE PALM.

Culture.—Properly irrigated, the date palm will grow in most of the Southwestern valley soils and in California; but does not thrive well either in certain excessively heavy clays or in light barren sands. Palms will grow in soils so alkaline as to kill out old, established, alfalfa; and remain uninjured by water standing at or near the surface of the soil for several months at a time. Only an unusual excess of soluble salts will inhibit the growth of date palms, small seedlings and suckers being more sensitive than established trees.

Localities.—The date palm occasionally ranges to an elevation of 3,500 feet in sheltered situations. At higher elevations, with shorter growing season, only the earliest varieties can be expected to ripen, while the hottest and longest seasons are too short to properly mature certain valuable late varieties. Medium and early ripening sorts are therefore best suited to our climatic conditions.

Cutting and Transplanting Suckers.—Many native seedlings, as well as imported varieties, are worthy of propagation, which is done by means of the off-shoots or suckers. Suckers should not be taken from the parent tree until they have attained a diameter of 5-6 inch and a weight of 15-20 pound. Suckers should be removed by cutting in and down along the line of cleavage between them and the main trunk, with a strong chisel or a sharp, flat-pointed bar. If possible the cut should be carried down so as to bring away at least one or two sound roots. The leaves should be closely pruned and for shipment the cut bases had better be protected against drying out by a layer of wet moss or similar material.

In planting, the sucker should be set in previously irrigated and well settled soil to the depth of its greatest diameter, taking care that the center of the palm is not below the irrigating water level.

For convenience in irrigating, a shallow basin of earth should be made about the sucker, in which, to lessen evaporation and the rise of alkali, a mulch of chip dirt or fine barnyard litter three or four inches deep should be spread. The soil about newly transplanted suckers should be kept constantly wet by frequent irrigations. Planted in this manner, from two to one hundred per cent of imported lots of suckers have been made to grow, according to their condition on arrival. Suckers should be cut and transplanted April to August, inclusive; but not during or approaching cool weather.

Enemies.—The most dangerous enemy of the date palm thus far encountered is the gopher (*Thomomys cervinus*) which feeds upon the roots and eats out the centers of the trees, and which, unchecked, will quickly destroy an entire orchard of palms. Rats, also (*Sigmodon hispidus eremicus,* Mearns) have been known to destroy a crop and damage the trees. A constant warfare must also be kept up against the birds, beetles, weevils, and flies which attack the crop.

Production.—While a little fruit is occasionally produced by suckers at two years after planting, commercial yields cannot be expected until about the sixth or eighth year. The waste, due to insects, handling, untimely rain and other causes, is sometimes very great. Several of the Old-World varieties have failed for various reasons. Some have required a longer growing season to mature; others have soured in damp or cool weather; and still others do not appeal to the American consumer. A few varieties have proved acceptable in all respects, and to such as these depends the future commercial developments. Certain seedling trees developed have produced early-maturing fruit of excellent quality. It is necessary, also, to develop an assortment of male palms which shall bloom at all times during the flowering season for fruit bearing trees in order that fresh pollen may be constantly available for this important operation. By reason of the difficulty, oftentimes, in securing numbers of desirable suckers from the Old World, and the fair proportion of successful seedlings usually obtained, those having ground and water to spare may wisely plant seed with a view to the ultimate establishment of a grove of valuable trees. Such seeds, in order to offer the best chance of success, should be derived from parent trees one or both of which should be characterized by excellence and earliness in the fruit. The resulting trees may therefore be expected to present a fair proportion of palms whose fruit shall combine excellence and earliness. They will come up more promptly if first stratified. This may be done by taking a deep box and placing 3 inches of sand in the bottom after making a number of holes in it for drainage. The seeds are placed upon this layer and the box filled with sand, the whole then being put in a sheltered place and kept moist for 3 to 6 weeks, when the seeds will be soft and ready for prompt growth when planted. The seedlings may be started either in nursery rows for transplanting, after one to three years, or, if frequent irrigations may be relied on, in the field where the trees are to remain. In the latter case, by making the rows 25 to 30 feet apart sufficient space remains for the culture of crops; and by planting 5 to 6 feet apart *in the rows,* provision having been made for the replacement, by cutting out and shifting in the row, of superfluous males and inferior female trees when their character becomes evident. The borders of alfalfa fields are also available for date palms, although some inconvenience to haying operations.

In conclusion, attention is directed to the fact that the date palm is valuable not only for its own products, but for the protection which it affords less hardy plants such as citrus fruits and certain vegetables, which may be grown in its shelter. In the Great Desert of Africa and in certain oases in Lower California such protection is necessary to the irrigated gardens beneath the palms, inasmuch as both the winter's frosts and the extreme heat of summer are mitigated thereby. For this purpose the date palm is ideal. Its deep root system, its lofty crown, and its straight trunk do not interfere with surface cultures; while its leaves afford sufficient but not too much shade for trees and plants beneath.

Looking to the undeveloped future, therefore, of a region which will some day be brought to the highest possible state of intensive cultivation, a grove of seedling palms, with possibilities of valuable new fruit-bearing varieties, and for protective shade, may be considered a wise investment. It is not advisable, however, for planters at this time to make heavy expenditures in date-palm culture, with expectation of prompt or certain profits for the reason that the subject is still in its experimental stage with respect to the all-important question of varieties best suited to the region.—(Ariz. E. S. Cir. 72.)

THE SMYRNA FIG.

Fig culture has never amounted to much as an industry in this country. Fig trees grow abundantly throughout the South and in California, having been introduced by the early French and Spanish settlers, and there have been more or less frequent importations since. As a domestic fruit, the fig is of considerable importance in all the Gulf and South Atlantic States. It is a common dooryard tree throughout this region. It has been grown with more or less success as far north as the lower Hudson River Valley, and where well cared for during the winter it will bear well for years, even at these northern limits. In the South figs are used almost entirely for household purposes. They are eaten fresh from the tree and are served on the table with sugar and cream. They are also stewed and made into puddings and pies, and are canned and preserved. In this section figs are occasionally, but seldom, dried for household use, as they ripen at the period of summer showers, which makes drying difficult. Much more of an effort to produce a salable dried fig has been made in California than in the South, especially during the last twenty years, and a greater success has been secured, probably on account of the drier climate.

The Smyrna fig, the standard fig of commerce, owes its peculiar flavor to the number of ripe seeds which it contains, and these ripe seeds are only to be gained by the fertilization of the flowers of the Smyrna fig with pollen derived from the wild fig, or caprifig. Since time immemorial it has been known that in Oriental regions it has been the custom of the natives to break off the fruits of the caprifig, bring them to the edible fig trees, and tie them to the limbs. From the caprifigs thus brought in there issues a minute insect, which, covered with pollen, crawls into the flower receptacles of the edible fig, fertilizes them, and thus produces a crop of seeds and brings about the subsequent ripening of the fruit.

Indications are that in very many localities in the interior valleys of California good crops of Smyrna figs can be raised, and there is little doubt that many persons will start orchards of Smyrna fig trees, with the proper springling of caprifigs. This statement holds not only for California, but unquestionably for good fruit-growing regions in New Mexico, Arizona, and Texas.—(Y. B. 1900.)

NUT FRUITS.

In the diversification of industries which is now deservedly attracting so much thought and attention, the increase of our plants of cultivation should find a plant, and of cultivated plants the nut-producing trees are among the most promising. The nut trees differ very much in certain particulars from other trees which produce edible fruits. They are of the first rank as to size, and the fruit is the true seed only, and is not made up of fleshy coverings of the seed as in the apple, peach, etc. Nuts have, therefore, much less water and a higher nutritive value generally. They are rather of the nature of staple articles of diet and approach the grains in food value. They are, moreover, not of the perishable class and are easily handled with little waste and risk. All of the nut trees are probably capable of improvement, and each has adaptation to its particular situation. One of the most promising in the United States is the chestnut.—(Pa. E. S. B. 36.)

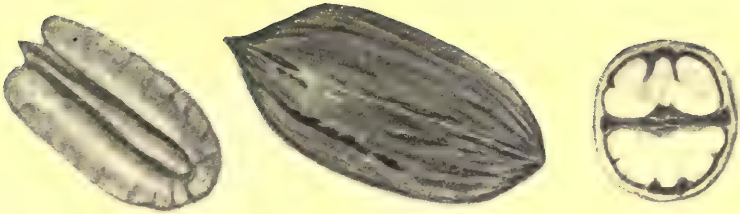
The Chestnut.—This is a native of the eastern United States, particularly the mountainous parts, where in the higher and drier soils it is one of the most common as it is one of the most useful of our trees. It is not as widespread as many others and is somewhat limited by soil conditions as well as by latitude. It is not a tree of wet or heavy soils, nor can it be grown successfully in them. Apparently it succeeds but poorly in limestone land, but whether from the lime which it contains or because of its heavy clayey character is not known. But in gravelly soils such as are common and extensive in hilly districts it grows luxuriantly, becomes well developed and productive. The localities in which it can be satisfactorily grown are hence quite readily determined. To some extent it can and has been grown in places where it is not native, and in soils not of light and gravelly nature, but generally imperfectly and with difficulty, and the trees have been sterile or at least irregular and uncertain in fruiting. It has been noticed that near the borders of the area in which this tree is native it is quite liable to be barren and to attain a meager size and development. To avoid disappointment one should satisfy himself that both climate and soil conditions are favorable before attempting chestnut culture.

The chestnut grows naturally from the seed or nut, and also reproduces itself indefinitely by sprouts from the base of the trunk. This second method is very common, particularly in newly cleared land, and makes more easy and rapid the renewal of these trees than of those kinds which grow from the seed alone.

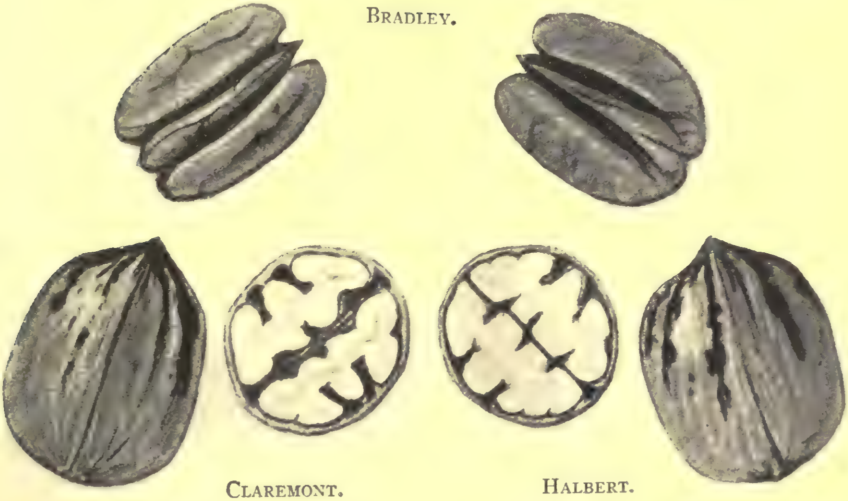
In growth from the seed it is found that the nuts lose their vitality in a remarkably short time, and hence special care must be taken either to plant them very soon after they are gathered or else to keep them so protected that their vitality is not impaired. Loss of vitality is practically coincident with loss of moisture, and nuts once dried will not germinate, while those partially dried will be more or less uncertain in their germinative powers. Nine-tenths of all failures in the germination of this and many other seeds usually comes from drying or the inability of the seed to procure sufficient moisture during germination. Nuts intended for planting should be kept buried in soil, or, better still, coarse saw dust or litter, slightly moist, until they can be planted. If possible nuts should be planted where the trees are to stand. The seedling is characterized by a remarkably long and vigorous tap root. It much exceeds the stem in both length and thickness. If allowed to grow without removal there is no check on growth; if transplanted it is impossible to avoid some mutilating of the roots, generally a loss of a considerable part of the tap root, and experience shows that in the chestnut tree this is more of an interference, and requires more time to recover from than in any of our common fruit trees, to say nothing of the occasional loss of a tree, which transplanting always involves.

When a chestnut tree is cut the stumps and roots still retain their vitality and a vigorous growth of young stems springs up, chiefly from the base of the stump. If left to themselves the stronger will smother and crowd out the weaker, but ordinarily several will remain to grow to maturity. This is still too many. They are crowded and are likely to grow crooked and imperfect. If desired for timber they should be left so close together that the growth will be thrown chiefly into the trunk, but if fruiting trees are wanted they should be gradually thinned out so that each of those remaining will have ample room for low, round-headed development.

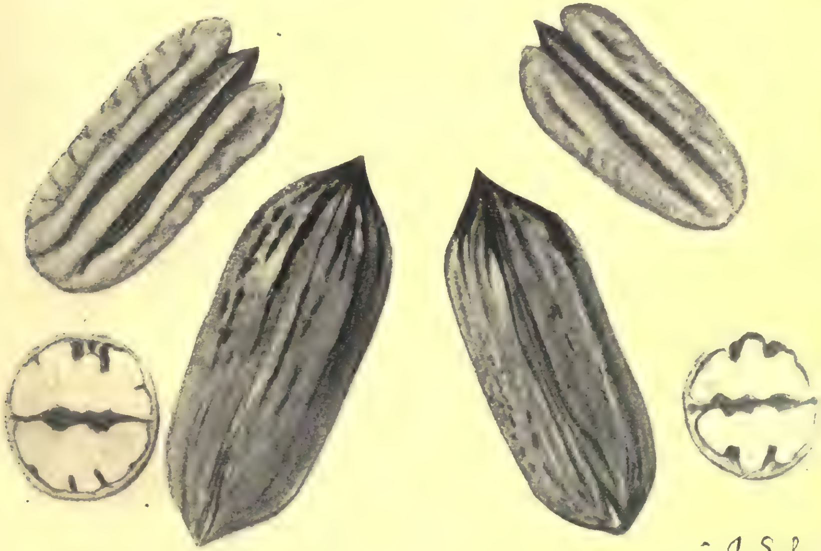
The chestnut tree is valuable for its wood and bark as well as for its fruit. The wood is characterized for its lightness and porosity, and is specially valuable for its durability. The specific gravity



BRADLEY.



CLAREMONT. HALBERT.



MOBILE. DAISY.

PECAN VARIETIES.
(See pages 309-313.)

averages about .45. It is porous because of the great number and large size of the vessels in the wood. These, as well as the wood cells themselves, do not become solid when the sap wood changes into heart wood, but retain more or less their open character. It thus absorbs or loses water, swells or shrinks readily, according to the condition of the air. Although light and brittle, and hence unsuited for some uses, its superior durability makes it one of the best of our native woods for many purposes. The bark has value for tanning, although not held in as high esteem for this purpose as that of several other trees.

The fruiting of the chestnut does not ordinarily occur until the tree has become at least ten or twelve years old, and when they are crowded not until much later, and then sparingly only on its uppermost branches. Low, round-headed trees having ample room for development, are the only ones which bear early and liberally. Hence, isolated trees on the borders of woods and fields are always the most productive. Blossoming occurs from June to July, according to latitude, and the fruits mature in from two and one-half to three months. The flowers are separated; the staminate, or male, conspicuous from the long finger-like spikes of the cluster on which the whitish flowers are arranged; the inconspicuous pistillate or female flowers are in small compact clusters, each of which latter is surrounded by prickley bracts which grow rapidly after the flowers are fertilized, forming the globular bur. Apparently fertilization is accomplished by the action of the wind, and there are some facts which seem to indicate that cross-fertilization is necessary. Lack of fruitfulness is due to a variety of circumstances, and here, as with other plants, the cause must be sought for sometimes outside of the flower. The nuts are too well known to need description. They are comparatively uniform in size, but vary greatly in abundance and perfection in different years. Imperfect fertilization and insect injury are the chief causes of this.

The native chestnut is but little variable in any respect, and has given scarcely any varieties, the history of which is known, or which are plainly distinguished from the type.

The European chestnut, however, has not only a marked natural peculiarity in the greater size of its nuts, but has given rise to varieties which are much superior to the wild type, and are highly valued by cultivators. Over thirty have been named and the common species is said to be but little used except as stock upon which to work the others. The varieties in most frequent cultivation are esteemed for the superior quality of their fruit more than for any other reason. The trees do not grow so large as the American, and come into bearing more quickly.

Within the past few years species from Japan have been introduced into the United States. Unfortunately they do not appear to be entirely hardy on their own roots, except in the south and some favored districts in the middle states. They are quite dwarf in habit, produce nuts larger even than the European, and begin to fruit when they are but four or five years old.

These two characters, of dwarf size and early fruitfulness, give them special value. The nuts of the latter, despite their large size, are not of the best quality. They lack sweetness, and the skin is often quite bitter and astringent, but as this is easily removed, and boiling makes the meat more palatable, this method of preparation is commonly employed in foreign countries where chestnuts have long been a favorite article of food. In this country they have never been looked upon in just that light, although a great many bushels are used every year, and the supply never equals the demand. Many districts in which the trees are abundant derive a very respectable income from the sale of the nuts, and it is obvious that this is an industry which can be made far more productive and profitable than it now is, since very little effort has been made toward cultivation. Only the natural, spontaneous product has been gathered.

In raising chestnut trees from the seed special care and pains should be taken to secure fresh nuts which have not had time to become dry, or have been carefully packed so as to preserve their moisture. It is surprising how quickly they lose moisture in a warm and dry atmosphere, and, as loss of moisture means loss of germinative power, too great pains can scarcely be taken with nuts intended for seed. They may be planted in the fall or buried in the ground until spring and then planted. The former is generally the better plan. The objection commonly raised to fall planting is the danger that the nuts will be destroyed by burrowing animals. This should be anticipated by planting at least twice as many as the number of trees desired. It may be doubted whether spring planted nuts are not fully as liable to destruction by this means as are any other.

Care should be taken that they are not carelessly put so deep that the stem finds difficulty in getting into the air, nor so poorly covered that they will dry out before germination. The use of the foot in seed sowing to press the ground about the nut should be carefully observed. On rough, stony ground containing roots of various shrubs all the operations of planting are more tedious than in other situations, but success cannot be had without proper observance of them. Very bushy land must be cut and burned over before planting. It must not be supposed that because the chestnut is a forest tree it will grow anywhere. After it is once thoroughly established it will hold its own, but in order to get a start and foothold it must have much the same help and protection which are given to any cultivated plant. The seedlings must have light and air and will not thrive in the shade nor when crowded by sprout-growth or other vegetation. Transplanting seedling trees can of course be done, but so far as experience goes, it is always attended by a check on growth and vigor which lasts two years or more, and they are easily outsripped by the others.

Transplanting larger trees is probably no more difficult than the transplanting of oak, hickory and other trees of this class, and, where time is an object and the number desired is not large, this means would naturally be employed.

Slating and sandy hills and mountain slopes like those so common throughout Pennsylvania offer excellent conditions for chestnut culture of this kind. Few of these lands are now cultivated at any profit; few are of any real value for pasturage even; many are utterly neglected and abandoned as no longer worth attention. A few acres on each farm planted to chestnuts would entail no great expense or labor, and would at least renew the wooded covering which protects the surface from washing, holds the leaves and vegetable debris, and gradually accumulates humus to enrich the soil. Few trees are more useful to the farmer in furnishing posts and other materials for farm uses; and, with proper care in thinning, trimming and protecting, they would in time become bearing trees—a chestnut orchard, as reliable a source of income as an orchard of any kind of fruit. The treatment of such an orchard would naturally vary very much with its situation. In ground easily worked, cultivation, for a few years at least, would be the easiest method of keeping down other plants and leaving the trees a clear field to occupy. In such instance close planting, only a few feet apart, would be advisable.

Where the surface is very stony or encumbered with stumps and refuse from former growth the cultivation would necessarily be limited to the immediate vicinity of the trees, and would, perhaps, be little more than cutting away about them to prevent their being smothered. It should be borne in mind, however, that neglect to do this so often and so thoroughly as is needed will result in the young trees becoming weakened and soon crowded out completely by their rivals. But where there is a natural sprout-growth of chestnut on land which, often, is abandoned and left to run to waste there is an excellent opportunity for securing an orchard of nut trees at a very small expense and trouble. The chestnut sprouts should be thinned out gradually until they are so far apart that they will not interfere with one another. Trees so exposed will develop short trunks and low, round-headed tops, and will come into bearing much sooner than otherwise. The trees and shrubs of other kinds should meanwhile be cut periodically, at least in so far as they directly interefere with the symmetrical development of the chestnuts, so that the latter will eventually occupy the whole ground. Had a little care of this kind been exercised over a very few only of the beautifully timbered lands of Pennsylvania after the cutting of the original growth there would now be many thousands of productive trees yielding a handsome revenue to their owners. In effect this is but giving a little attention to the second growth which appears after every cutting of chestnut land, and thus turning its energy into a particular channel. When the small amount of labor necessary to do this is considered it is surprising that more do not undertake it. It will be necessary to afford some protection from fire and trespassers, but what reasons can be given for not protecting and enforcing the rights on property of this kind as on any other?

But such sprout-growths can be treated in another way. If taken when they are still young and small they can be grafted with scions of any of the named varieties which are now offered by nurserymen. In general, preference has been given to whip or tongue grafting the sprouts which are half an inch or thereabouts in diameter. This is a more rapid method than cleft grafting, and by it a closer contact with the stock can be obtained, and the grafts are less easily displaced. Should the graft fail to grow, cleft grafting the succeeding year will often be required on account of the increased size which the sprouts have reached. Grafts should be set up two or three feet from the ground; even then the tendency is to make low and broad tops. Sometimes the union is imperfect and a knob or irregular swelling shows where the grafting was done. But more commonly no distinct mark is left after two or three years time, and in many trees it is impossible to distinguish where the union has taken place.

Grafted chestnut trees are precocious. The grafts of the Japanese sorts on sprout land frequently set fruit the same year of insertion, and their early bearing tendencies often present a satisfactory development of the tree. Two year old grafts are commonly loaded with burs in both Japanese and European kinds, though the Japanese varieties as a class bear earlier, both when grafted and from seed. It would probably be a profitable undertaking to keep the burs picked from the young trees for three or four years, in order that they might become strong and thoroughly established before the strain of reproduction is upon them. The young trees should also be pruned to an open spreading form, with three to five main branches on which the top will eventually form, after which the trees themselves will need little care other than good culture.

It goes without the saying that chestnuts are salable, and that the market has never yet been overstocked. Indeed, the market is generally quickly sold out, and this in spite of the fact that they are not perishable by any means and there is no need of forcing their sale. The larger grafted nuts are particularly attractive, since the average customer will pick out the big ones every time, and the size of the fruit outranks every other consideration.

European or Japanese Varieties.—One of the first considerations to confront the prospective commercial chestnut grower is, "Shall the European or the Japanese varieties be planted, or both?" The question is a difficult one to discuss without awakening enmity, for both species have equally earnest advocates. However, the attempt will be made to place their merits side by side as impartially as possible, basing the estimate not on a limited observation of a few trees, but on an acquaintance with both species growing together on a large commercial scale.

JAPANESE GROUP.

Advantages.

1. Early maturity of tree.
2. Ease of caring for trees.
3. Early ripening of nuts.
4. Large size of nuts.
5. Enormous productiveness.
6. Small size of bur.
7. Freedom from Leaf-Blight.
8. Freer from worms than Europeans.
9. The money makers in the large groves
10. Affinity for American Stocks.
11. Ornamental value.

Disadvantages.

1. Overbearing, if not thinned.
2. Poorer quality of many.
3. Delicate growth of some.

EUROPEAN GROUP.

Advantages.

1. Great productiveness of some.
2. Timber value of tree.
3. Finer quality.
4. Beautiful appearance of nuts of some.
5. Prolific bearing of a few.

Disadvantages.

1. Late maturity of many.
2. Late ripening of nuts.
3. Shy bearing of many when young.
4. Largeness of bur, which may become water-soaked and break the trees.
5. Great susceptibility to Leaf-Blight.
6. Greater suspectibility to weevil.
7. Do not compare with Japanese in the commercial groves as money makers.

It can be stated as a general principle, that the Japanese Flora is better fitted to the climatic conditions of the Eastern United States than the flora of Western Europe, the latter succeeding best on the Pacific Coast. Hence it is thought that if the Japanese species is used as a basis for further improvement, happier results will eventually follow its amelioration in the Eastern United States. The Japanese or European varieties, as they exist, should be looked upon only as stepping-stones to better kinds. By the continued judicious selection of seedlings from varieties of the best flavor, the quality of the Japanese chestnut can be greatly improved in a few generations. Some of the finer quality of the chinquapin or of the native chestnut might be infused into the Japanese with happy results, and a more vigorous tree would follow the incorporation of a little European blood. One type should supplement the other wherever the adaptability of both is proven.

Estimate of Varieties.—The varieties of the cultivated chestnuts are not well enough established, nor have they been grown on a sufficiently comprehensive scale to determine their horticultural value. Some of the most promising kinds are confined to a few trees only. It is therefore impossible to compare the various kinds justly. The first list is based upon the behavior of the varieties that are growing on an extensive scale, the second list includes those kinds which are promising, but which have not been grown extensively.

Varieties Grown Extensively.
Japanese — Alpha, Reliance, Parry. First Choice.
European—Paragon. First Choice.
Numbo. Second Choice.

Varieties not in Large Blocks, but Promising.
Japanese — Kerr, Kent, Killen. First Choice.
Biddle, Felton, Martin. Second Choice.
European—Ridgely, Scott, Styer. First Choice.
Dager, Darlington. Second Choice.

The Hale, McFarland, and Coe are spoken of highly.—(Pa. E. S. B. 36; Del. E. S. B. 42.)

THE PECAN.*

The amount of pecans annually consumed in the country has been steadily increasing from year to year, and there has at the same time been a steady increase in the market value of the nuts. Nuts of very ordinary grade, such as are commonly used by nurserymen for raising stocks for nursery work, could be bought five or six years ago for half what they now sell for. There has been, as well, a corresponding increase in the value of the product marketed for culinary and dessert purposes. The better grade of nuts are taken entirely by a private trade, and the demand cannot be supplied, and there appears to be no immediate prospect of its being met, because the increasing demand is more than keeping pace with increased production. The pecan is destined to take the lead among tree nuts used in this country, and in fact among all fruits classed as nuts, the peanut excepted.

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* For illustration, see page 303.

The pecan tree is indigenous in the United States in the rich, alluvial bottoms of the Mississippi. Its northern limit is about Davenport, Iowa. In the Mississippi Valley proper it extends to within about seventy-five miles of the Gulf of Mexico. This was its southern limit in that region, though farther west it extends into Mexico. The statement is generally made that the pecan will succeed wherever the larger species of hickory are found, and this is doubtless true, as the pecan belongs to the same family of trees (*Juglandaceæ*) and to the same genus (*Carya*) as the hickory.

The peculiar conditions of soil and moisture surrounding the pecan in its native home might be regarded as an indication that it could not be grown except on deep, rich soil, in proximity to rivers, ponds or streams. Such, however, would be a wrong inference, for it succeeds admirably and bears good crops on a wide range of soils. Hence, it is found today in localities far removed from the regions to which it is indigenous, and thriving under conditions differing greatly from those obtaining in its native home.

Moisture in sufficient quantity must be present, but it will not do to plant the pecan on land that is continually wet and soggy. The presence of a hard, impenetrable subsoil doubtless has a great influence upon the welfare of the tree, and it would be better to select other ground, or when this is impossible, to blast out the hardpan. A quicksand subsoil is equally objectionable. If close to the surface, it should not be used. The roots cannot penetrate it. All things considered the best soil is probably one which has previously supported a growth of holly, willow-leaved oak, dog-wood, hickory and those other trees usually found associated with them. A sandy loam with a clay or sandy clay subsoil is difficult to surpass.

The land intended for young trees should be well prepared. This preparation will depend largely upon the care and treatment which the soil has received previously. Land on which the forest still stands should preferably be thoroughly cleared and put in cultivation for a year or two before planting. Leguminous crops are excellent to precede the setting of the trees. Plow the ground thoroughly, break deeply, harrow it level and it is ready for the trees.

The best trees for general planting are well grown one-year-old trees, from three to five feet high. The color of the bark, the shape, size and arrangement of the lenticels, the size and shape of the buds are always characteristic and by these marks varieties can be distinguished. Every planter should acquaint himself with the wood characteristics of the varieties. By far the safest plan in buying trees is to deal directly with honest nurserymen who give their business careful thought and attention.

Because the pecan grows as a forest tree in some parts of the country, many people suppose that it can be left without care and cultivation, left as any other tree in the fields and woods is left to shift for itself. But if fruit is required from the tree, no matter whether planted in the garden or the orchard, it should be given good care. Too many practices are based upon ideas taken from the native trees of the woods and fields.

One lesson can be learned from the woods. The ideal soil condition for the pecan grove is that found in the forest. The soil there is filled with vegetable matter, and humus; it holds water and plant food. The aim in the cultivation of the trees should be to provide and maintain a soil as nearly ideal as that.

This is best done by planting the land between the tree rows in cotton, peanuts or other field crops, in vegetables, cowpeas, beggarweed or velvet beans. The last mentioned crops may be used in making hay. These are the ideal crops for the pecan orchard. It would be best to follow a systematic rotation of these crops.

The area grown in these crops should by no means equal the total area of the field. The tree rows for a width of four or five feet on each side should not be planted in crops during the first year. This strip should, however, be cultivated during the first part of the season. The cultivated area will necessarily become more restricted each year, and eventually the ground will have to be given up to the trees.

The greatest demand made on the soil by the tree is for nitrogen and this can be met by applying stable manure, or by growing leguminous crops and turning them under as already directed. In the fertilizing of the pecan this is by all means the best policy. The potash in the form of sulphate or muriate of potash and the phosphoric acid in the form of acid phosphate can be supplied separately.

As a general rule the pecan requires comparatively little pruning. At the time of planting the young trees should be cut back some distance, particularly if they are very tall. It is well to have the main branches form within four or five feet of the ground. After this about all the pruning necessary is to remove dead or injured branches and cut back those which have a tendency to run up beyond their neighbors. For this work, as well as in procuring grafts or budwood from the top of the tree, the tree pruner comes into good service.

Top-worked trees frequently require considerable pruning to get them started so that they will develop into shapely, symmetrical trees.

Harvesting and Marketing.—The pecan crop is not so difficult to harvest and prepare for market as a crop of oranges or peaches, for instance, and yet some care must be taken to put the nuts on the market in inviting shape.

The equipment necessary for harvesting consists of an extension ladder, a step ladder, a number of bamboo fishing poles and picking sacks. The best kind of step ladder is one having three legs instead of four. Picking sacks may be made from ordinary hemp or jute sacks. The sack should be spread open with a piece of stick, sharp-pointed at both ends, placed in one side of the mouth, thus making the opening triangular. Place a pecan nut in the lower corner of the sack, tie one end of a piece of stout twine about it as it lies in the corner, and then tie the other end of the twine to the center of the mouth of the sack opposite the stick. The twine should be short enough to draw the bottom and top of the sack close together, leaving an opening through which the arm may be thrust and the sack slung over the shoulder.

As soon as the greater percentage of the burs have opened, the crop should be gathered. It will not do to wait until all have opened, neither is it advisable to pick the trees over a number of times. Pick them clean at one picking. The burs of those nuts which are fully matured will open; the burs of immature ones may not. The latter should be discarded.

The men should climb the trees and pick the nuts by hand, using the bamboo poles only for those which are entirely out of reach. Even this should be done carefully so as not to injure the bearing wood of the trees. Care in picking good nuts by hand will amply repay the grower, because the beating and shaking of the trees will cause a considerable quantity of fruit to be lost, and a few pounds saved will repay all the time and trouble. Of course, in very high trees, there is frequently nothing to do but to shake and thrash the crop off the trees. The plan of covering the ground beneath the trees with a large sheet would work well and assist in reducing losses. As soon as taken from the trees the nuts should be spread out under a shed or in a building to dry. A very convenient plan, and one which will save space, is to provide a sufficient number of trays, three feet by four feet, and three inches deep, with half-inch mesh wire bottoms, and place the nuts in these, two or two and a half inches deep. Racks can be provided around the room in which to place these. In from ten days to two weeks from the time of picking, the nuts should be cured.

Grading.—The variety should be made the basis of the grade; that is, each variety should be picked, packed and marketed by itself. This besides gives an excellent opportunity to compare the commercial value of different kinds. When a grower has a large number of different kinds of seedling nuts, and a small quantity of each, they may be graded by passing them through screens.

At the present time practically all of the common market nuts are both polished and colored. Coloring should not be resorted to, and in the case of good varieties of nuts polishing should not be done. In the case of small or mixed lots, however, polishing is useful in making the nuts more uniform. It can be accomplished by putting the nuts with a little dry sand in a barrel fixed so that it can be rotated like a revolving churn and turning until the nuts receive the desired polish. The better nuts, however, should be put on the market just as they come from the trees. The markings, dots and streaks on the outside are their trademark, and should not be interfered with.

For shipping small quantities of pecans by express nothing is better than a box. Barrels are best for larger shipments. For mail shipments stout pasteboard, wooden or tin boxes or tin cans make good packages. Frequently shipments are made in sacks, but the sack does not afford sufficient protection to the contents and should not be used. As a rule the box should be made so that a given weight will fill it, but this difficulty may be overcome, to a certain extent, by putting in a pad of paper or excelsior—paper being preferable. Fill the packages on a solid floor, shaking them down well and putting in all they will hold, placing the pad, if one has to be used, in the bottom.

On the outside of the packages before shipping should be placed the name of the grower, the variety, the number of pounds and the shipping directions. Small boxes to be shipped by express for the holiday trade should be wrapped in good quality wrapping paper before shipping.

Marketing.—The best plan for marketing good pecan nuts is to build up a private trade. As a matter of fact, at the present time but very few of the large, full-meated pecans find their way into the general market. They are either taken by seedsmen or consumed by private customers. In building up a private trade advertising has its place, of course. Advertisements inserted in magazines or papers, particularly in those which are published in the tourist towns of the State, may be found helpful.

The object and aim should be to give each private customer a package, bright, neat, attractive and containing the best quality of nuts. If a certain price per pound is fixed for a given quality, then this should not be varied under any circumstances. Each year the same quality of nuts should be given to each customer. It will not do to give large ones one year and smaller ones the next; this tends to create dissatisfaction. In some of the larger cities there are high-class fruit dealers who handle nothing but fruits, nuts, etc., of the very highest quality. Under some circumstances it might be well to enter into negotiations with such firms.

A satisfactory commercial pecan nut must be prolific, of good size, good quality, must not be spasmodic in its bearing, plump, with a bright, presentable exterior and preferably a light-colored kernel. The nuts should besides yield sixty per cent or upwards of kernels. All these things in one variety makes a difficult combination to secure. Undue weight must not, however, be given to size, for size and quality are usually antagonistic to each other. In fact, in pecans as in other fruits we must go to the small or medium sized ones for the best quality. No variety of pecan is superior to San Saba in quality, yet it is a small nut. Other varieties which may be regarded as standards of quality are Schley and Curtis. The former is a medium to large nut and medium prolific variety, while Curtis is of medium size, precocious and prolific.—(Fla. E. S. B. 54, 85.)

THE WALNUT.

The English walnut (*Juglans regia*) has been grown for centuries in western Asia, especially Persia, whence it has been introduced by invaders and traders to various parts of Europe, namely Italy, Spain, France, Germany, and England; and it is moreover variously named after all these countries. From Europe it was introduced into America and for over a hundred years walnuts have grown in different parts of New York State, and farther south; but the large planting has been in California. There the industry was introduced by the Spanish friars, who brought with them the Spanish strain, which is a soft-shelled type, such as the Soft Shell and the Santa Barbara. Walnuts have been introduced into South America also. In later years French strains of such varieties as the Franquette and Mayette have made their appearance, and the introduction of these bids fair to revolutionize the walnut industry in America.

There is no tree that demands as much care as the walnut in the selection of the soil, especially when grown on English walnut roots. It is claimed, and reasonably, that when grafted on either American Black or California Black, the tree will stand heavier soil. The walnut is a heavy feeder and the soils that suit it best are the good, deep, rich, moist loams, at least fifteen feet deep and well drained, although these are not necessarily the only soils upon which it will grow. The soils to be avoided are those which are underlaid near the surface by hardpan, and those underlaid near the surface with rock, cement gravel, or loose gravel. In the former the tap root will grow for a short time but cannot penetrate the hardpan, and the tree will cease growing. The latter soils should never be selected—they are too light and thin. The preparation of the ground should be about the same as for a fruit orchard—good deep plowing and thorough harrowing will bring their rewards.

The tree should be carefully set, taking care, as with a fruit orchard, to have the trees thoroughly lined and set firmly. The distance recommended is from fifty to sixty feet apart. Under some conditions the trees might be planted thirty feet apart and later every other tree taken out. Eventually five to seven trees to the acre would be sufficient, and the yield from these would be from three hundred to a thousand pounds, which, at present prices, would bring handsome profits.

The walnut requires little or no pruning. Care should be taken the first four or five years to keep nearly all laterals removed. This will cause the tree to make a rapid terminal growth, and when the laterals do begin to grow they will not come down close to the ground as is the case with young trees where the laterals are allowed to remain necessitating the cutting off of quite large limbs. This keeping the laterals off also gives a much larger tree, as the growth that would naturally go into the laterals is forced into the terminal growth, the young tree sometimes making seven or eight feet of growth in one season. The young trees should always be staked and tied with broad strips of cloth to prevent cutting. From time to time dead wood will need to be removed from the tree and occasionally a few limbs taken out to guard against having the tree grow too thick; but care should be taken not to remove large limbs. When this is done be sure to make a slanting cut so as to shed the water, and then wax it to keep it dry, as exposed pith will rapidly decay. The walnut trees do not all begin fruiting at the same age. In Oregon the average is from four to ten years, but some trees that are considered to be barren at ten years old, later come into bearing. The yield of nuts the first year is very light—probably four or five nuts to the tree. The second year, two to five pounds; and trees from fifteen to twenty years old yield as high as three bushels on the average, while old trees yield from fifteen to twenty bushels. The walnut, if given proper treatment, will live to a ripe old age. There are trees in parts of Europe that are known to be three hundred years old; but some California trees have been removed when they were thirty years of age, it being claimed that they had outlived their usefulness. This was probably due, in every case, to too close planting. When proper distances are allowed and the air circulates freely in among the trees, they live naturally for centuries, and this is one of the most attractive features of the walnut industry. In establishing orchards the foundations for prosperity are laid for a great many generations.

The nuts are not harvested until fully ripe and the husks begin to split open. Light shaking of the trees will then cause most of the mature nuts to drop. As the walnut does not ripen uniformly, it will be necessary to gather the fruit at intervals for several weeks. In some countries it is the practice to beat the fruit from the trees but the California growers believe that this is more of an injury than a help as it often seems to knock off a great many buds. With care, however, a long, light bamboo pole may be of some service. When the nuts are gathered, the husks should be removed and the nuts washed and rinsed, for, if the hulls are allowed to remain on the nuts, they will cause a staining, thus depreciating the market value of the nuts. Where only a few nuts are grown, probably the husks can be removed by hand; but where nuts are grown on quite a large scale it may be necessary to make some kind of barrel or drum in which the nuts can be churned. One of these can be easily made by taking a common water barrel and making an opening on the side through which the nuts can be put in, and then revolving the barrel on some form of axis. In some cases it is the practice to add a little sand, and in France it is sometimes customary to give them a soapstone polish, which makes the shells very smooth and gives them somewhat of a greasy feeling. After the nuts are washed they must be cured.

They are then allowed to remain out in the sun until properly cured, which will take about three days. It will be a good plan to stir the nuts several times each day, and, where they are left out at night, to have some kind of covering of canvas to throw over them to keep away the dews. In some cases they are dried by artificial heat, being placed in a temperature of at least one hundred degrees Fahrenheit for a number of hours, depending, of course, upon the degree of heat. After the nuts are cured they should be placed in a rather cool, dry atmosphere, where they can be kept until shipped. If not cured and kept in good condition the nuts will become rancid and be unsalable. It is the practice in some parts of California, and also abroad, to bleach the nuts by means of sulphur. This practice, while whitening the shell, causes the quality of the nuts to deteriorate.

Varieties.—The question of variety is one every grower must solve. Time alone will settle the supremacy of any variety or varieties over others; but it is only reasonable to suppose that the walnut, like the apple, will demonstrate that each variety is adapted to certain conditions, and fills a valuable place either commercially or as a home nut. Already certain characteristics are being associated with each variety—thus, the Proepurturien bears while very young and the nut is of fine quality, being an excellent home nut. The Chaberte seems adapted to high altitudes and poor soils, and the kernels separate easily. The Franquette is noted for its good size and prolificness; the Mayette, for extra good quality; and so on down the list.

Marketing.—The walnut is generally marketed in sacks. These hold from one hundred to one hundred twenty pounds. The more progressive growers screen the nuts, assorting the different sizes, as the prices range more or less according to size. The Chaberte nuts, however, and some soft shelled types, cannot be sacked, as the shell is too thin to warrant rough handling. These nuts are crated. With the reputation established in the packing of fruit, there is a standard, in a way, to follow in handling the walnut. In other words, there will probably be a market for the better grade of nut handled in attractive packages. As the tendency is for small gift packages of fruit, so it will be with the walnut, and attractive packing and packages will undoubtedly bring splendid returns. In the countries where the walnuts are being grown in large quantities, quite a number are being picked green for picklings and catsup manufacturing.

Some persons have shown more or less alarm in regard to the walnut market, claiming that it would be very easy to overstock it. Now nuts are becoming more and more a staple of diet with the American people, due to several reasons—increase in wealth, and the scarcity and increase in price of meat. In California the production is increasing but slowly—less than four thousand tons in nine years; and it has been estimated that if it should double that amount in the next ten years, or, say, if the increase should be a thousand pounds a year for the next twenty years, that would mean only forty million pounds, or less than one-half pound for every person in the United States. This means that the population of the country is increasing more rapidly than the combined ratio of imported and native nuts. At the lowest figures an orchard in full bearing would yield good profits, considering the amount of labor necessary, as at least six hundred pounds of nuts could be expected from an acre. It has been estimated in California that a yield of three hundred pounds an acre would be profitable.—(Ore. E. S. B. 92.)

ADDITIONAL REFERENCES.

Factors That Make Up a Good Fruit Growing Section.—Colo. E. S. B. 2; Calif. E. S. R. 1892-3.

Cultivation and Cover Crops.—Ia. E. S. B. 44; Cornell E. S. B.

61; O. E. S. B. 171; Mont. E. S. B. 77; Mo. E. S. B. 8; Calif. E. S. R. 1892-3; Calif. E. S. R. 1896-7; Mich. E. S. R. 1901; N. Dak. E. S. B. 49; N. Y. E. S. R. 1896; Cornell E. S. B. 198; Del. E. S. R. 1903-04-05-06; Wis. E. S. R. 1907; Nebr. E. S. B. 92; Mich. E. S. B. 27; Wis. E. S. R. 1904; Mich. E. S. B. 213; Nebr. E. S. B. 79; R. I. E. S. R. 1896; Mich E. S. R. 1898; Cornell E. S. B. 72; Cornell E. S. B. 102; Cornell E. S. B. 69; Ills. E. S. B. 59; Ills. E. S. B. 52; R. I. E. S. B. 83; Nebr. E. S. B. 39; Colo. E. S. B. 142; N. H. E. S. B. 110; Utah E. S. B. 37; Ala. E. S. B. 2; B. P. I. B. 190.

Fertilizer Requirements of Fruit Crops.—Mass. E. S. R. 1894; Miss. E. S. B. 2; Cornell E. S. B. 153; Conn. E. S. R. 1895; Mass. E. S. B. 66; Fla. E. S. B. 14; N. J. E. S. R. 1900-01-02; Cornell E. S. B. 117; Cornell E. S. B. 102; Cornell E. S. B. 69; Ills. E. S. B. 59; R. I. E. S. B. 83; Tenn. E. S. R. 1899; Mich. E. S. B. 81; Pa. E. S. R. 1893.

Varieties, Planting, and Pruning.—N. C. E. S. B. 92; Colo. E. S. B. 2; Okla. E. S. R. 1907; Va. E. S. 127; Va. E. S. B. 161; Cornell E. S. B. 69; Ills. E. S. B. 59; R. I. E. S. B. 83; W. Va. E. S. R. 1896; Wash. E. S. Bs. 51, 52, 53; Okla. E. S. R. 1901; Idaho E. S. B. 43; Ore. E. S. B. 93; Ark. E. S. B. 55; Okla. E. S. B. 20; Cornell E. S. B. 153; Mich. E. S. B. 168; N. H. E. S. B. 105; W. Va. E. S. B. 27; Utah E. S. B. 83; Wash. E. S. B. 25; Colo. E. S. B. 106; Colo. E. S. B. 139; Mass. E. S. B. 66; Me. E. S. R. 1891; Minn. E. S. B. 81; Mich. E. S. B. 205.

Orchard Protection.—Ala. E. S. R. 1898; Ia. E. S. B. 31; Ind. E. S. B. 53; Mich. E. S. B. 11; Ore. E. S. R. 1901; Mass. E. S. B. 1, 2, 7; Nebr. E. S. B. 39; N. Mex. E. S. B. 75; Nebr. E. S. B. 79; Minn. E. S. B. 2; Okla. E. S. B. 20.

Irrigation and Drainage of Orchards.—Colo. E. S. B. 2; Utah E. S. B. 39; Ariz. E. S. B. 37; Ariz. E. S. R. 1899-1900; U. S. E. S. B. 108; U. S. E. S. B. 131; U. S. E. S. B. 145.

Harvesting, Marketing, and Storing Fruit.—N. C. E. S. B. 92; Tenn. E. S. B. 3; Hawaii E. S. B. 14; Idaho E. S. B. 43; Oew. E. S. B. 101; W. Va. E. S. B. 74; Kans. E. S. B. 84; Md. E. S. B. 116; Cornell E. S. 8. 117; Ore. E. S. B. 51; B. P. I. B. 40.

Botany of Cultivated Fruit Plants.—Cornell E. S. B. 19; Wis. E. S. R. 1900; Mich. E. S. B. 40; N. Y. E. S. B. 299; R. I. E. S. R. 1903-5-7; Idaho E. S. R. 1905; Vt. E. S. B. 119; Mo. E. S. B. 10; Wis. E. S. R. 1901; Calif. E. S. R. 1892-3-5; Ore. E. S. B. 34; Ia. E. S. B. 13; N. J. E. S. R. 1890; N. Y. E. S. B. 299; B. P. I. B. 22.

Propagation of Fruit Plants.—Ia. E. S. B. 14; Tex. E. S. R. 1893; N. C. E. S. B. 92; Colo. E. S. B. 2; Ia. E. S. B. 3; Mass. E. S. B. 2; Ills. E. S. B. 21; Hawaii E. S. B. 20; W. Va. E. S. R. 1896; Me. E. S. B. 49; S. Dak. E. S. B. 50; Cornell E. S. B. 25; W. Va. E. S. B. 54; B. P. I. B. 202.

The Apple.—Va. E. S. B. 48; B. P. I. B. 56; Cornell E. S. B. 226, 229; Va. E. S. B. 136, 137; O. E. S. B. 73; Ia. E. S. B. 72; Va. E. S. B. 130; O. E. S. 137; O. E. S. B. 217; Md. E. S. B. 144;

Ind. E. S. B. 102; Ore. E. S. B. 81, 82; Va. E. S. B. 137; Vt. E. S. B. 141; No. E. S. B. 61; Pa. E. S. B. 43; Kans. E. S. B. 106; Mass. E. S. B. 62, 66; Mich. E. S. B. 262; Vt. E. S. B. 55; Ark. E. S. B. 71, 91; N. C. E. S. B. 182; Idaho E. S. B. 64; W. Va. E. S. B. 74; Mont. E. S. B. 66; Mass. E. S. R. 1894; Ore. E. S. B. 94; Mass. E. S. R. 1903; Idaho E. S. B. 54; Va. E. S. B. 57.

Pear and Quince.—Pear.—N. J. E. S. B. 142; Del. E. S. R. 1900; Va. E. S. B. 49; N. J. E. S. R. 1899. Quince.—Cornell E. S. B. 80; Mass. E. S. R. 1903.

The Peach.—Ga. E. S. B. 42; Md. E. S. B. 72; Mich. E. S. B. 103; Mo. E. S. B. 38; N. J. E. S. B. 133, 197; N. Mex. E. S. B. 30; Cornell E. S. B. 74; N. C. E. S. B. 120; O. E. S. B. 170; Tex. E. S. B. 80; F. B. 33; Ala. E. S. B. 156; N. Mex. E. S. B. 76; Ont. E. S. R. 1909; Nectarine.

Apricots, Plums, Prunes, Cherries.—Apricot.—Cornell E. S. B. 71; Ariz. E. S. B. 16. Plums.—Cornell E. S. B. 38; Vt. E. S. B. 89; Ia. E. S. B. 46; Ga. E. S. B. 67; Mich. E. S. B. 103; Ala. E. S. B. 85; Mass. E. S. R. 1904; Mich. E. S. B. 27. Prunes.—Wash. E. S. B. 38; Ore. E. S. B. 40, 45. Cherries.—Cornell E. S. B. 98; Del. E. S. B. 35.

The Grape.—Ala. E. S. B. 110; Ont. Ag. R. 1909; F. B. 471; B. P. I. B. 172; Calif. E. S. B. 146, 148; Mo. E. S. B. 46; Kans. E. S. B. 110; Tenn. E. S. B. 77; Ga. E. S. B. 53; Tex. E. S. B. 56; Tex. E. S. B. 48; Calif. E. S. B. 193; S. C. E. S. B. 132; Calif. E. S. B. 180; Mo. E. S. B. 23; Tex. E. S. B. 88; Y. B. 1902; Ala. E. S. B. 4, 110; Wis. E. S. B. 13, 17; Okla. E. S. R. 1900; Colo. E. S. B. 141; N. C. E. S. B. 201.

Small Fruits.—Raspberry.—Cornell E. S. B. 57, 100; W. Va. E. S. B. 48; Minn. E. S. B. 39; Ills. E. S. B. 30; N. J. E. S. B. 126. Blackberries.—Ga. E. S. B. 33; Cornell E. S. B. 57, 99; N. J. E. S. B. 126. Currant.—N. Y. E. S. B. 95; N. J. E. S. B. 126; Ore. E. S. B. 22. Gooseberries.—N. Y. E. S. B. 114; N. J. E. S. B. 126; Ore. E. S. B. 122; Ind. E. S. B. 33. Strawberries—Ont. Ag. R. 1909; N. H. E. S. B. 137; Kans. E. S. B. 55; Ga. E. S. B. 48; Miss. E. S. B. 19; Colo. E. S. B. 140, 53; N. H. E. S. B. 74; S. Dak. E. S. B. 103; Tenn. E. S. B. 2; O. E. S. B. 178; Fla. E. S. B. 39; Ind. E. S. B. 73; Cornell E. S. B. 189; Miss. E. S. B. 75; Ark. E. S. B. 48; N. Dak. E. S. B. 31; Ala. E. S. B. 94, 109; Tex. E. S. B. 72; Ky. E. S. B. 73; S. C. E. S. B. 49; S. C. E. S. B. 49; N. J. E. S. B. 126.

Citrus Fruit.—Oranges.—Fla. E. S. B. 33; La. E. S. B. 36; Porto Rico E. S. B. 4. Pomelo.—Fla. E. S. B. 58.

Southern Fruit (Subtropical).—Persimmon.—Tenn. E. S. B. 11; Ind. E. S. B. 60; Fla. E. S. B. 71; La. E. S. B. 99; Ala. E. S. B. 98. Pineapples.—Porto Rico E. S. B. 8; Fla. E. S. B. 37, 50, 82, 84, 101. Olives.—Ariz. E. S. B. 62; Calif. E. S. B. 104, 129, 137. Dates.—Ariz. E. S. B. 29; B. P. I. B. 53, 54; Figs.—Ga. E. S. B. 61; La. E. S. B. 112.

Nut Fruits.—Chestnuts.—Fla. E. S. B. 1; N. C. E. S. B. 105; Pa. E. S. B. 16. Pecans.—La. E. S. B. 69; Miss. E. S. B. 124; B. P. I. B. 30; Fla. E. S. B. 57.

PART II

FORESTRY AND CONSERVATION.

INTRODUCTION.

Forestry is the preservation of the forests by wise use, in its broadest sense. Preservation by wise use not only means the economic handling of the natural forests, but also the commercial and economical planting of forest trees in places now barren. In many ways it is the most vital problem in the United States, directly as well as indirectly, to the farmer as well as the lumberman. By saving the forests the prosperity of each individual and of the nation is increased and preserved. The primary object of the forest policy of the United States is the making and preserving of prosperous homes upon which rest the foundations of our Government. —(Theodore Roosevelt—F. S. Cir. 25.)

INFLUENCE OF FORESTS ON AGRICULTURE.

The Forest Waters the Farm.—Whether forests increase the amount of precipitation within or near their limits is still an open question, although there are indications that under certain conditions large, dense forest areas may have such an effect. At any rate, the water transpired by the foliage is certain, in some degree, to increase the relative humidity near the forest, and thereby increase directly or indirectly the water supplies in its neighborhood. This much we can assert, also, that while extended plains and fields, heated by the sun, and hence giving rise to warm currents of air, have the tendency to prevent consideration of the passing moisture-bearing currents, forest areas, with their cooler, moister air strata, do not have such a tendency, and local showers may therefore become more frequent in their neighborhood. But, though no increase in the amount of rainfall may be secured by forest areas, the availability of whatever falls is increased for the locality by a well-kept and properly located forest growth. The foliage, twigs, and branches break the fall of the raindrops, and so does the litter of the forest floor, hence the soil under this cover is not compacted as in the open field, but kept loose and granular, so that the water can readily penetrate and percolate; the water thus reaches the ground more slowly, dripping gradually from the leaves, branches, and trunks, and allowing more time for it to sink into the soil. This percolation is also made easier by the channels along the many roots. Similarly, on account of the open structure of the soil and the slower melting of the snow under a forest cover in spring, where it lies a fortnight to a month longer than in exposed positions and melts with less waste from evaporation, the snow waters more fully penetrate the ground. Again, more snow is caught and preserved under the forest cover than on the wind-swept fields and prairies.

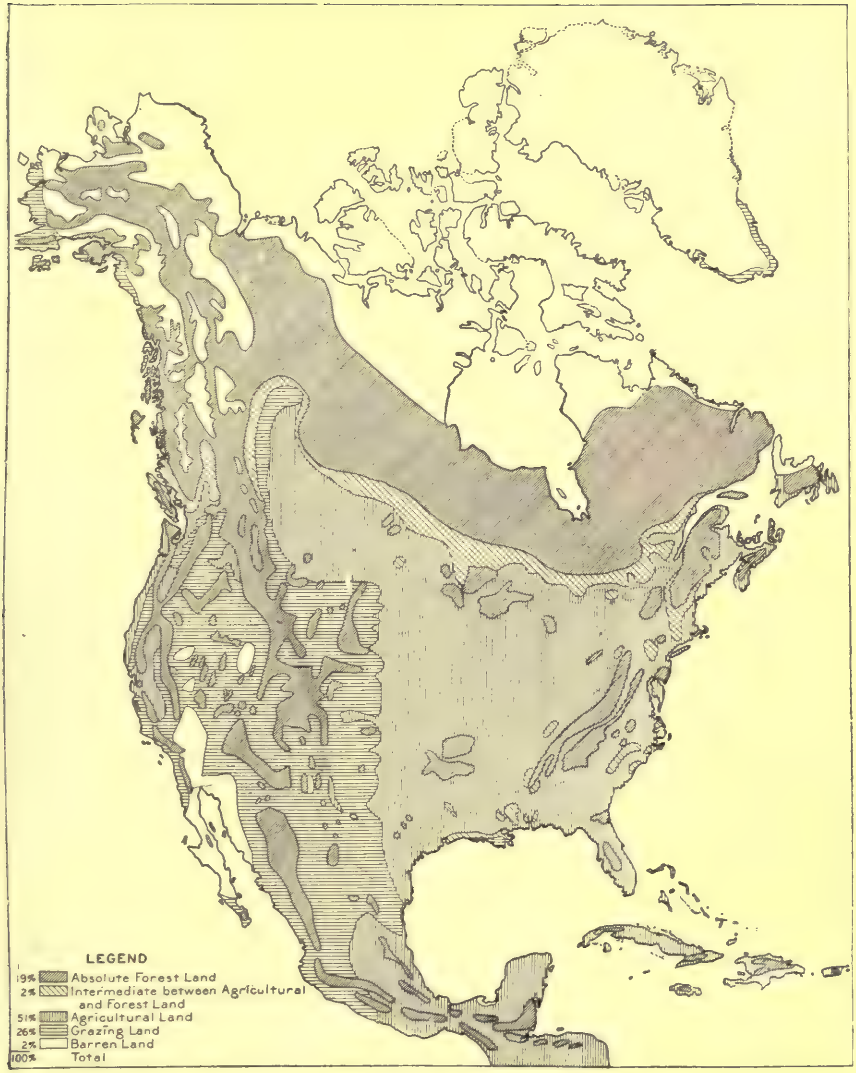
All these conditions operate together with the result that larger amounts of the water sink into the forest soil and to greater depths than in open fields. This moisture is conserved because of the reduced evaporation in the cool and still forest air, being protected from the two great moisture-dissipating agents, sun and wind. By these conditions alone the water supplies available in the soil are increased from 50 to 60 per cent over those available on the open field. Owing to these two causes, then—increased percolation and decreased evaporation—larger amounts of moisture become available to feed the springs and subsoil waters, and these become finally available to the farm, if the forest is located at a higher elevation than the field. The great importance of the subsoil water especially, and the influence of forest areas upon it, has so far received too little attention and appreciation. It is the subsoil water that is capable of supplying the needed moisture in times of drought.

The Forest Tempers the Farm.—Another method by which a forest belt becomes a conservator of moisture lies in its wind-breaking capacity, by which both velocity and temperature of winds are modified and evaporation from the fields to the leeward is reduced.

On the prairie, wind swept every day and every hour, the farmer has learned to plant a wind-break around his buildings and orchards, often only a single row of trees, and finds even that a desirable shelter, tempering both the hot winds of summer and the cold blasts of winter. The fields he usually leaves unprotected; yet a wind-break around his crops to the windward would bring him increased yield, and a timber belt would act still more effectively.

Not only is the temperature of the winds modified by passing over and through the shaded and cooler spaces of protecting timber belts disposed toward the windward and alternating with the fields, but their velocity is broken and moderated, and since with reduced velocity the evaporative power of the winds is very greatly reduced, so more water is left available for crops. Every foot in height of a forest growth will protect 1 rod in distance, and several belts in succession would probably greatly increase the effective distance. By preventing deep freezing of the soil the winter cold is not so much prolonged, and the frequent fogs and mists that hover near forest areas prevent many frosts. That stock will thrive better where it can find protection from the cold blasts of winter and from the heat of the sun in summer is a well-established fact.

The Forest Protects the Farm.—On the sandy plains, where the winds are apt to blow the sand, shifting it hither and thither, a forest belt to the windward is the only means to keep the farm protected. In the mountain and hill country the farms are apt to suffer from heavy rains washing away the soil. Where the tops and slopes are bared of their forest cover, the litter of the forest floor burnt up, the soil trampled and compacted by cattle and by the patter of the raindrops, the water can not penetrate the soil readily,


LEGEND
19% Absolute Forest Land
2% Intermediate between Agricultural and Forest Land
51% Agricultural Land
26% Grazing Land
2% Barren Land
100% Total

but is carried off superficially, especially when the soil is of clay and naturally compact. As a result the waters, rushing over the surface down the hill, run together in rivulets and streams, and acquire such a force as to be able to move loose particles, and even stones; the ground becomes furrowed with gullies and runs; the fertile soil is washed away; the fields below are covered with silt; the roads are damaged; the water courses tear their banks, and later run dry because the waters that should feed them by subterranean channels have been carried away in the flood.

The forest cover on the hilltops and steep hillsides which are not fit for cultivation prevents this erosive action of the waters by the same influence by which it increases available water supplies. The important effects of a forest cover then, are retention of larger quantities of water and carrying them off under ground and giving them up gradually, thus extending the time of their usefulness and preventing their destructive action.

In order to be thoroughly effective, the forest growth must be dense, and, especially, the forest floor must not be robbed of its accumulations of foliage, surface mulch and litter, or its underbrush by fire, nor must it be compacted by the trampling of cattle. On the gentler slopes, which are devoted to cultivation, methods of underdraining, such as horizontal ditches partly filled with stones and covered with soil, terracing, and contour plowing, deep cultivation, sodding, and proper rotation of crops, must be employed to prevent damage from surface waters.

The Forest Supplies the Farm with Useful Material.—All the benefits derived from the favorable influence of forest belts upon water conditions can be had without losing any of the useful material that the forest produces. The forest grows to be cut and to be utilized; it is a crop to be harvested. It is a crop which, if properly managed, does not need to be replanted; it reproduces itself. When once established, the ax, if properly guided by skillful hands, is the only tool necessary to cultivate it and to reproduce it. There is no necessity of planting unless the wood lot has been mismanaged.

The wood lot, then, if properly managed, is not only the guardian of the farm, but it is the savings bank from which fair interest can be annually drawn, utilizing for the purpose the poorest part of the farm. Nor does the wood lot require much attention; it is to the farm what the workbasket is to the good housewife—a means with which to improve the odds and ends of time, especially during the winter, when other farm business is at a standstill. It may be added that the material which the farmer can secure from the wood lot, besides the other advantages recited above, is of far greater importance and value than is generally admitted.

On a well-regulated farm of 160 acres, with its 4 miles and more of fencing, and with its wood fires in range and stove, at least 25 cords of wood are required annually, besides material for repair of buildings, or altogether the annual product of probably 40 to 50 acres of well-stocked forest is needed. The product may represent, according to location, an actual stumpage value of from $1 to $3 per acre, a sure crop coming every year without regard to weather, without trouble and work, and raised on the poorest part of the farm. It is questionable whether such net results could be secured with the same steadiness from any other crop. Nor must it be overlooked that the work in harvesting this crop falls into a time when little else could be done.

Wire fences and coal fires are, no doubt, good substitutes, but they require ready cash, and often the distance of haulage makes them rather expensive. Presently, too, when the virgin woods have been still further culled of their valuable stores, the farmer who has preserved a sufficiently large and well tended wood lot will be able to derive a comfortable money revenue from it by supplying the market with wood of various kinds and sizes. The German State forests, with their complicated administrations, which eat up 40 per cent of the gross income, yield, with prices of wood about the same as in our country, an annual net revenue of from $1 to $4 and more per acre. Why should not the farmer, who does not pay salaries to managers, overseers, and forest guards, make at least as much money out of this crop, when he is within reach of a market?—(Y. B. 1895.)

Rock River Valley Conditions.—For some years past the Rock River, in Wisconsin and Illinois, has been decreasing its volume, or at least changing in the regularity of its flow. In summer the upper tributaries and smaller creeks have occasionally run dry. Should these changes continue, they would interfere with various industrial interests of the region. Numerous mills and other manufacturing plants in the towns along the river depend upon its water power. There are also dams and locks for slack-water navigation at the principal cities. A canal that extends across the State of Illinois from the lower end of the Rock River to the Illinois River draws upon the Rock River for a part of its water supply. Moreover, the agricultural interests of southeastern Wisconsin, including extensive cultivated and pasture lands situated among the numerous headwaters and smaller tributaries of the Rock River, rely to some extent upon these sources for sustained moisture in the soil, particularly during seasons of irregular or diminished rainfall. These various industries—manufactures, transportation, and agriculture—are closely dependent upon a steady water supply, and therefore upon the forest, which is an agency of the first importance to this end.

Besides their importance as an agency in regulating the water flow, the forests of the Wisconsin watershed add to the attractiveness of the region, which is annually visited by many people because of its beautiful scenery and the excellent fishing and shooting it affords.

A possible method of equalizing the flow is through the agency of forest growth. The present condition is largely the result of forest destruction and forest deterioration incidental to the agricultural development of the region. In this case, therefore, the question becomes, can it be shown to landowners in the region that it would pay them individually to have a larger part of their farms timbered, or to improve the character of their woodland?

It is believed that the present condition of the average wood lot, in this region is such that the owners are now suffering an actual loss of a considerable part of their value, and that the area now wooded might often be extended with a resulting clear profit to the farm. It is further believed that this added return may be secured by anyone of ordinary intelligence and enterprise, without expert assistance and without the outlay of capital or any expenditure other than that of a little time and forethought.

In the case of the forested area again the controlling principle must be the advantage of the individual owner. It is not proposed to turn good farm land into woods, with the certain result of a net loss on the crop. But there is much land naturally better adapted for woodland than for agriculture. In many cases this now supports a sparse and inferior growth of timber, or none at all. A little care on the part of the owner would result in his having eventually a much more productive and valuable wood lot, and would at the same time help to equalize the stream flow, and so would benefit the whole region.—(F. S. B. 44.)

Forests and Snow in the West.—The intimate connection between the melting snows of the mountains and the mountain forests and the agricultural prosperity of Colorado, and this relation may be extended to the other western States dependent for irrigation on the melting snows, is too evident to those acquainted with conditions to need discussion, for most of the water which carries fertility to the fields and farms comes from the white-capped mountains. It is not believed that the forests materially affect the rainfall. Their important function is in saving the snow from premature melting and the effect of the winds which increase the evaporation. The action of the forests in protecting the snow from rapid melting not only allows a gradual distribution of water for irrigation purposes during the growing season, but also protects the agricultural interests from sudden, destructive floods. The loss of the forest cover means more violent fluctuation during the day, greater difficulty in regulating the headgates and keeping a uniform flow in ditches and hence an additional difficulty in the economic distribution of water. Also the water runs off sooner, hence the streams drop earlier in the summer and on account of the lessening of the springs, the smaller is the water flow. The preservation of the forest is an absolute necessity for the interest of irrigated agriculture.—(Colo. Ex. St. Bul. 55.)

Comparison of Run-Off from Forested and Nonforested Areas.—There are so many complex conditions influencing the flow of streams that it is extremely difficult to determine the effect of forests on run-off by the comparison of the discharge of streams on forested and nonforested catchment areas. It is believed by many that stream flow is so largely influenced by the amount, intensity, and character of the precipitation, the configuration and area of the catchment basin, the character of the absorbing medium and the underlying rocks, and the general climate, as well as the forest itself, that we shall probably never be able to measure quantitatively the influence of forests on the flow of streams by the comparison of forested and nonforested regions. Catchment areas differ so greatly in the features mentioned above that our most conservative and able investigators have been forced to the conclusion that "in respect to run-off, each stream is a law unto itself." Although the above is probably in the main true, yet, by the careful selection of small catchment basins for comparison, it appears that the influence of the forest in diminishing the surface run-off can be determined with a fair degree of accuracy. When the catchment areas compared are in the same region, are influenced by the same or nearly the same climate and precipitation and by the same storms, have approximately the same configuration and area, and have a similar mineral soil and underlying rocks, the effect of these various factors on the run-off can be ignored, and the differences in the behavior of the stream flow on the forested and nonforested areas can be assigned to the influence of the forest.

General Discussion.—When a farmer in Ohio or Indiana has a piece of woods on fairly level ground he has no good reason for keeping it as woods unless he considers the wood growing on the land to be as valuable as any other crop he might raise—a matter often difficult to decide. A farmer in Mississippi, on the other hand, may be induced to leave a patch of forest on a hillside, not because he cares much for the wood, but because, if the forest is cut away, the land will wash into a labyrinth of deep gullies and soon become utterly worthless for any purpose. In the former case the forest is merely for the crop it yields; in the latter it is for both crop and protection, and this case is far more common than is usually supposed. But while the farmer in Mississippi may use the forest to keep a piece of land from gullying, and thus use it as a protection against erosion, he cares little as to how this forest affects the flow of water or the climate, for he has ample rain and does not utilize the creek or stream. With the farmer in Gallatin Valley, Montana, this is quite different. He takes what seems to be a desert gravel bar and by the use of 1 inch (miner's) of water per acre he converts this arid ground into a farm and raises as high as 90 bushels of a superior quality of oats per acre. To him the little mountain stream is everything. Here the forest takes on another function; it holds the soil of the neighboring mountains and keeps it more pervious, and thus it regulates the flow in these important streams. The manner in which it does this will be clearer from the following: Suppose we take a table and tilt it several inches, so that its top represents a slanting surface. If we sprinkle water on this surface, it is clear that the water runs off about as fast as it strikes the table. If the table is now covered with a layer of soil about 3 inches thick, and the sprinkling is renewed, some of the water runs off from the surface and some soaks into the layer of soil, so that if, after a time, we quit sprinkling there will still be water running off from the table for hours. We have here then a "surface run-off" and an "underground run-off," and it is clear that the thicker the layer of earth, and the more pervious, the more water it would take up and the longer and steadier it would be giving off this underground water.

The above statement shows exactly what happens all over the land, and is especially noticeable in the mountains. On the soilless, rocky slopes the water runs off as fast as it falls or the snow melts, but on slopes with deep, pervious soils part of the water is stored and continues to flow for months after the rain or the melting of snow has ceased.

Returning to the experiment with the layer of earth on the table, we notice that if we sprinkle more briskly, part of the earth is carried away, the layer is eroded, and the storage ground is diminished. If covered by a layer of cotton batting this erosion stops, and in addition we gain another very important point—the soil is kept softer, and allows water to soak in more easily than when the cotton is wanting, for then the water "pats" down; it hardens the surface where it does not wash it away. Much the same result might be obtained by sowing grass on the layer of earth, for then the tops of the grass would keep the drops from pounding the earth, form a mechanical obstacle to the surface run-off, and the roots would be an additional help in holding the earth and keeping it from washing away. But the grass is small, its tops are short, open, and close to the ground; its roots are short; it rarely forms a dense sod, and, especially in dry countries, it leaves a large part of the ground without protection. Here, then, the larger, long-lived, deep-rooted trees, with dense, shading crowns high above the ground, give far better and more constant protection against erosion, and are far better able to keep the ground in a pervious condition, since they strew it annually with large quantities of leaves and twigs and provide a network of slowly decaying roots which keep the forest soil mellowed for a foot and more in depth. An upturned hemlock, spruce, etc., will readily illustrate how much of the ground is occupied by the roots of these forest trees.

The trees, then, are in nature what the cotton is in the experiment; they help to keep the soil from being carried away, they keep it soft, and they break the force of the downpouring rain.

How much additional service trees perform by keeping sun and wind from the ground is well illustrated by the forests of the Lake States and Canada, where thousands of swamps have dried up and hundreds of miles of corduroy road have become useless, not by ditching and draining, but by removing the woods and giving sun and wind access to the soil.

Though there exists numerous forests in this country where the protective function of the woods is not apparent, in the majority of cases, and in all mountain districts without exception, the forest serves both to supply useful material and to protect and improve the ground, and thereby regulate the surface and underground drainage.—(Y. Book.)

GENERAL PRINCIPLES OF FORESTRY FOR FARMERS.

This country varies so greatly in soil, climate, and flora that it is only possible, within the limits assigned for the present discussion, to outline general principles everywhere applicable. Wherever suggestions have approximated the laying down of rules of practice, the writer had mainly in mind the conditions prevalent in our northeastern States.

The succeeding chapters should be read connectedly. The first treats of the behavior of a forest plant; the second, of the principles which should guide the planter in setting a crop; the third, of the manner in which a natural forest crop should be produced; and the fourth chapter points out how the crop should be managed afterwards in order to secure the best results in quantity and quality of material.

How Trees Grow.—Trees, like most other plants, originate from seed, build up a body of cell tissues, form foliage, flower, and fruit, and take up food material from the soil and air, which they convert into cellulose and other compounds, from which all their parts are formed. They rely, like other plants, upon moisture, heat, and light as the means of performing the functions of growth. Yet there are some peculiarities in their behavior, their life and growth, which require special attention on the part of a tree grower or forest planter, and these we shall briefly discuss.

Trees derive their food and solid substance in part from the air and in part from the soil. The solid part of their bodies is made up of cellulose, which consists largely of carbon (44 per cent of its weight), with hydrogen and oxygen added in almost the same proportions as in water. The carbon is derived from the carbonic acid of the air, which enters into the leaves and, under the influence of light, air, and water, is there decomposed; the oxygen is exhaled; the carbon is retained and combined with elements derived from the water, forming compounds, such as starch, sugar, etc., which are used as food materials, passing down the tree through its outer layers to the very tips of the roots, making new wood all along the branches, trunk, and roots.

This process of food preparation, called "assimilation," can be carried on only in the green parts, and in these only when exposed to light and air; hence foliage, air, and light at the top are essential prerequisites for tree growth, and hence, other conditions being favorable, the more foliage and the better developed it is, and the more light this foliage has at its disposal for its work, the more vigorously will the tree grow. In general, therefore, pruning, since it reduces the amount of foliage, reduces also, for the time, the amount of wood formed; and just so shading, reducing the activity of foliage, reduces the growth of wood.

Soil Conditions.—From the soil trees take mainly water, which enters through the roots and is carried through the younger part of the tree to the leaves, to be used in part on its passage for food and wood formation and in part to be given up to the air by transpiration.

In a vigorously growing tree the solid wood substance itself will contain half its weight in the form of water chemically combined, and the tree, in addition, will contain from 40 to 65 per cent and more of its dry weight in water mechanically or "hygroscopically" held. This last when the tree is cut very largely evaporates, yet well-seasoned wood still contains 10 to 12 per cent of such water. The weight of a green tree, a pine, for instance, is made up, in round numbers, of about 30 per cent of carbon and 70 per cent of water, either chemically or hygroscopically held, while a birch contains a still larger percentage of water.

The largest part of the water which passes through the tree is transpired—i. e., given off to the air in vapor. The amounts thus transpired during the season vary greatly with the species of tree, its age, the amount of foliage at work, the amount of light at its disposal, the climatic conditions (rain, temperature, winds, relative humidity), and the season. These amounts are, however, very large when compared with the quantity retained; so that while an acre of forest may store in its trees, say, 1,000 pounds of carbon, 15 to 20 pounds of mineral substances, and 5,000 pounds of water in a year, it will have transpired—taken up from the soil and returned to the air—from 500,000 to 1,500,000 pounds of water (one-quarter to one-half as much as agricultural crops).

Mineral substances are taken up only in very small quantities, and these are mostly the commoner sorts, such as lime, potash, magnesia, and nitrogen. These are carried in solution to the leaves, where they are used (as perhaps also on their passage through the tree), with a part of the water, in food preparation. The main part of the mineral substances taken up remains, however, as the water transpires, in the leaves and young twigs, and is returned to the soil when the leaves are shed or when the tree is cut and the brush left to decompose and make humus.

Hence the improvement of the fertility of the soil by wood crops is explained, the minerals being returned in more soluble form to the soil; as also the fact that wood crops do not exhaust the soil of its minerals, provided the leaves and litter are allowed to remain on the ground. For this reason there is no necessity of alternating wood crops, as far as their mineral needs are concerned; the same kind of trees can be grown on the same soil continuously, provided the soil is not allowed to deteriorate from other causes.

As the foliage can perform its work of food assimilation only when sufficient water is at its disposal, the amount of growth is also dependent not only on the presence of sufficient sources of supply, but also on the opportunity had by the roots to utilize the supply, and this opportunity is dependent upon the condition of the soil. If the soil is compact, so that the rain water can not penetrate readily, and runs off superficially, or if it is of coarse grain and so deep that the water rapidly sinks out of reach of the roots and can not be drawn up by capillary action, the water supply is of no avail to the plants; but if the soil is porous and moderately deep (depth being the distance from the surface to the impenetrable subsoil, rock, or ground water) the water not only can penetrate but also can readily be reached and taken up by the roots.

The moisture of the soil being the most important element in it for tree growth, the greatest attention must be given to its conservation and most advantageous distribution through the soil. No trees grow to the best advantage in very dry or very wet soil, although some can live and almost thrive in such unfavorable situations. A moderately but evenly moist soil, porous and deep enough or fissured enough to be well drained, and yet of such a structure that the water supplies from the depths can readily be drawn up and become available to the roots—that is the soil on which all trees grow most thriftily. The agriculturist procures this condition of the soil as far as possible by plowing, drainage, and irrigation, and he tries by cultivating to keep the soil from compacting again, as it does under the influence of the beating rain and of the drying out of the upper layers by sun and wind.

The forest grower can not rely upon such methods, because they are either too expensive or entirely impracticable. He may, indeed, plow for his first planting, and cultivate the young trees, but in a few years this last operation will become impossible and the effects of the first operation will be lost. He must, therefore, attain his object in another manner, namely, by shading and mulching the soil. The shading is done at first by planting very closely, so that the ground may be protected as soon as possible from sun and wind, and by maintaining the shade well throughout the period of growth. This shade is maintained, if necessary, by more planting, and in case the main crop in later life thins out inordinately in the crowns or tops, or by the accidental death of trees, it may even become desirable to introduce an underbrush.

The mulching is done by allowing the fallen leaves and twigs to remain and decay, and form a cover of rich mold or humus. This protective cover permits the rain and snow waters to penetrate without at the same time compacting the soil, keeping it granular and in best condition for conducting water, and at the same time preventing evaporation at the surface. The soil moisture, therefore, is best maintained by proper soil cover, which, however, is needful only in naturally dry soils. Wet soils, although supporting tree growth, do not, if constantly wet, produce satisfactory wood crops, the growth being very slow. Hence they must be drained and their water level sunk below the depth of the root system.

Irrigation is generally too expensive to be applied to wood crops, except perhaps in the arid regions, where the benefit of the shelter belt may warrant the expense. Attention to favorable moisture conditions in the soil requires the selection of such kinds of trees as shade well for a long time, to plant closely, to protect the woody undergrowth (but not weeds), and to leave the litter on the ground as a mulch. Different species, to be sure, adapt themselves to different degrees of soil moisture, and the crop should therefore be selected with reference to its adaptation to available moisture supplies

While, as stated, all trees thrive best with a moderate and even supply of moisture, some can get along with very little, like the conifers, especially pines; others can exist even with an excessive supply, as the bald cypress, honey locust, some oaks, etc. The climate, however, must also be considered in this connection, for a tree species, athough succeeding well enough on a dry soil in an atmosphere which does not require much transpiration, may not do so in a drier climate on the same soil. In the selection of different kinds of trees for different soils, the water conditions of the soil should, therefore, determine the choice.

Light Conditions.—To insure the largest amount of growth, full enjoyment of sunlight is needed. But as light is almost always accompanied by heat and relative dryness of air, which demands water from the plant, and may increase transpiration from the leaves inordinately, making them pump too hard, as it were, young seedlings of tree species whose foliage is not built for such strains require partial shading for the first year or two. The conifers belong to this class.

In later life the light conditions exert a threefold influence on the development of the tree, namely, with reference to soil conditions, with reference to form development, and with reference to amount of growth. The art of the forester consists in regulating the light conditions so as to secure the full benefit of the stimulating effect of light on growth, without its deteriorating influences on the soil and on form development.

As we have seen, shade is desirable in order to preserve soil moisture. Now, while young trees of all kinds, during the "brush" stage of development, have a rather dense foliage, as they grow older they vary in habit, especially when growing in the forest. Some, like the beech, the sugar maple, the hemlock, and the spruce, keep up a dense crown; others, like the chestnut, the oaks, the walnut, the tulip tree, and the white pine, thin out more and more, and when fully grown have a much less dense foliage; finally, there are some which do not keep up a dense shade for any length of time, like the black and honey locust, with their small, thin, leaves; the catalpa, with its large but few leaves at the end of the branchlets only, and the larch, with its short, scattered bunches of needles. So we can establish a comparative scale of trees with reference to the amount of shade which they can give continuously, as densely foliaged and thinly foliaged, in various gradations. If we planted all beech or sugar maple, the desirable shading of the soil would never be lacking, while if we planted all locust or catalpa the sun would soon reach the soil and dry it out, or permit a growth of grass or weeds, which is worse, because these transpire still larger quantities of water than the bare ground evaporates or an undergrowth of woody plants would transpire. Of course, a densely foliaged tree has many more leaves to shed than a thinly foliaged one, and therefore makes more litter, which increases the favorable mulch cover of the soil. Another reason for keeping the ground well shaded is that the litter then decomposes slowly, but into a desirable humus, which acts favorably upon the soil, while if the litter is exposed to light, an undesirable, partly decomposed "raw" humus is apt to be formed.

Favorable soil conditions, then, require shade, while wood growth is increased by full enjoyment of light; to satisfy both requirements, mixed planting, with proper selection of shade-enduring and light-needing species, is resorted to.

As the different species afford shade in different degrees, so they require for their development different degrees of light. The dense foliage of the beech, with a large number of leaves in the interior of the crown, proves that the leaves can exist and perform their work with a small amount of light; the beech is a shade-enduring tree. The scanty foliage of the birches, poplars, or pines shows that these are light-needing trees; hence they are never found under the dense shade of the former, while the shade-enduring can develop satisfactorily under the light shade of the thin-foliaged kinds. Very favorable soil conditions increase the shade endurance of the latter, and climatic conditions also modify their relative position in the scale.

All trees ultimately thrive best—i. e., grow most vigorously—in the full enjoyment of light, but their energy then goes into branching. Crowded together, with the side light cut off, the lower lateral branches soon die and fall, while the main energy of growth is put into the shaft and the height growth is stimulated. The denser shade of the shade-enduring kinds, if placed as neighbors to light-needing ones, is most effective in producing this result, provided that the light is not cut off at the top; and thus, in practice, advantage is taken of the relative requirements for light of the various species. The forester finds in close planting and in mixed growth a means of securing tall, clear trunks, free from knots, and he is able, moreover, by proper regulation of light conditions, to influence the form of development, and also the quality of his crop, since slow growth and rapid growth produce wood of different character.

There are some species which, although light foliaged and giving comparatively little shade, are yet shade enduring—i. e., can subsist, although not develop favorably, under shade; the oaks are examples of this kind. Others, like the black cherry, bear a dense crown for the first twenty years, perhaps, seemingly indicating great shade endurance; but the fact that the species named soon clears itself of its branches and finally has a thin crown, indicates that it is light needing, though a good shader for the first period of its life. Others, again, like the catalpa, which is shady and shade enduring, as the difficulty with which it clears itself indicates, leaf out so late and lose their foliage so early that their shading value is thereby impaired. Black locust and honey locust, on the other hand, leave no doubt either as to their light-needing or their inferior shading quality.

That soil conditions and climatic conditions also modify crown development and shade endurance has been well recognized abroad, but in our country this influence is of much more importance on account of the great variations in those conditions. Thus the box elder, an excellent shader in certain portions of the West, is a failure as soil cover in others where it nevertheless will grow.

We see, then, that in determining the shading value as well as the shade endurance of one species in comparison with another, with reference to forestry purposes, not only soil and climate but also the character of foliage and its length of season must be considered.

Physiology of Tree Growth.—As we have seen, root and foliage are the main life organs of the tree. The trunk and branch serve to carry the crown upward and expose it to the light, which is necessary in order to prepare the food and increase the volume of the tree, and also as conductors of food materials up and down between root and foliage. A large part of the roots, too, aside from giving stability to the tree, serve only as conductors of water and food material; only the youngest parts, the fibrous roots, beset with innumerable fine hairs, serve to take up the water and minerals from the soil. These fine roots, root hairs, and young parts are therefore the essential portion of the root system. A tree may have a fine, vigorous-looking root system, yet if the young parts and fibrous roots are cut off or allowed to dry out, which they readily do—some kinds more so than others—thereby losing their power to take up water, such a tree is apt to die. Under very favorable moisture and temperature conditions, however, the old roots may throw out new sprouts and replace the fibrous roots. Some species, like the willows, poplars, locusts, and others, are especially capable of doing so. All trees that "transplant easily" probably possess this capacity of renewing the fibrous roots readily, or else are less subject to drying out. But it may be stated as a probable fact that most transplanted trees which die soon after the planting do so because the fibrous roots have been curtailed too much in taking up, or else have been allowed to dry out on the way from the nursery or forest to the place of planting; they were really dead before being set. Conifers—pines, spruces, etc.—are especially sensitive; maples, oaks, catalpas, and apples will, in this respect, stand a good deal of abuse. Hence, in transplanting, the first and foremost care of the forest grower, besides taking the sapling up with least injury, is the proper protection of its root fibers against drying out.

The water, with the minerals in solution, is taken up by the roots when the soil is warm enough, but to enable the roots to act they must be closely packed with the soil. It is conveyed mostly through the outer, which are the younger, layers of the wood of root, trunk, and branches to the leaves. Here, as we have seen, under the influence of light and heat it is in large part transpired and in part combined with the carbon into organic compounds, sugar, etc., which serve as food materials. These travel from the leaf into the branchlet, and down through the outer layers of the trunk to the very tips of the root, forming new wood all the way, new buds, which lengthen into shoots, leaves, and flowers, and also new rootlets. To live and grow, therefore, the roots need the food elaborated in the leaves, just as the leaves need the water sent up from the roots. Hence the interdependence of root system and crown, which must be kept in proportion when transplanting. At least, the root system must be sufficient to supply the needs of the crown.

Sap Up and Sap Down.—The growing tree, in all its parts, is more or less saturated with water, and as the leaves, under the influence of sun and wind and atmospheric conditions generally transpire, new supplies are taken in through the roots and conveyed to the crown. This movement takes place even in winter, in a slight degree, to supply the loss of water by evaporation from the branches. In the growing season it is so active as to become noticeable; hence the saying that the sap is "up," or "rising," and when, toward the end of the season, the movement becomes less, the sap is said to be "down." But this movement of water is always upward; hence the notion that there is a stream upward at one season and in one part of the tree, and a stream downward at another season and perhaps in another part of the tree, is erroneous. The downward movement is of food materials, and the two movements of water upward and food downward take place simultaneously, and depend, in part at least, one upon the other, the food being carried to the young parts, wherever required, by a process of diffusion from cell to cell known as "osmosis."

These food materials are, by the life processes of the active cells, changed in chemical composition as need be, from sugar, which is soluble, into starch, which is insoluble, and back into sugar, and combined with nitrogenous substances to make the cell-forming material protoplasm.

In the fall, when the leaves cease to elaborate food, both the upward and the downward movement, more or less simultaneously, come to rest (the surplus of food materials, as starch, and sometimes as sugar, being stored for the winter in certain cell tissues), to begin again simultaneously when in spring the temperature is high enough to reawaken activity, when the stored food of last year is dissolved and started on its voyage. The exact manner in which this movement of water upward and food materials downward takes place, and the forces at work, are not yet fully understood, nor is there absolute certainty as to the parts of the tree in which the movement takes place. It appears, however, that while all the so-called "sapwood" is capable of conducting water (the heartwood is probably not), the most active movement of both water and food materials takes place in the cambium (the growing cells immediately beneath the bark) and youngest parts of the bark.

The deductions from these processes important to the planter are: That injury to the living bark or bast means injury to growth, if not destruction to life; that during the period of vegetation transplanting can be done only with great caution; that the best time to move trees is in the fall, when the leaves have dropped and the movement of water and food materials has mostly ceased, or in spring, before the movement begins again, the winter being objectionable only because of the difficulty of working the soil and of keeping the roots protected against frost. All things considered, spring planting, before activity in the tree has begun, is the best, although it is not impossible to plant at other times.

Progress of Development.—Like the wheat or corn plant, the tree seed require as conditions for sprouting sufficient moisture, warmth, and air. Tree seeds, however, differ from grain in that most of the kinds lose their power of germination easily; with few exceptions (locust, pine, spruce), they can not be kept for any length of time. The first leaves formed often differ essentially in shape from those of the mature tree, which may cause their being confounded with other plants, weeds, etc.

The little seedlings of many, especially the conifers, are quite delicate, and remain very small the first season; they need, therefore, the protecting shade of mother trees, or artificial shading, and also protection against weeds. The amount of light or shade given requires careful regulation for some of them; too much light and heat will kill them, and so will too much shade. This accounts for the failure of many seedlings that spring up in the virgin forest. The planter, then, is required to know the nature and the needs of the various kinds of seeds and seedlings, so as to provide favorable conditions, when he will avoid sowing in the open field such as require the care which it is impracticable to give outside of the nursery.

Growth in Length and Ramification.—While the stalk of wheat or corn grows for one season, exhausts itself in seed production, and then dies, the tree continues to grow from season to season, in length as well as in thickness. The growth in length of shaft and branches proceeds from buds, made up of cell tissues, which can subdivide and lengthen into shoots, as well as make leaves. These buds are formed during summer, and when winter begins contain embryo leaves, more or less developed, under the protecting cover of scales. When spring stimulates the young plant to new activity, the buds swell, shed their scales, distend their cells, increasing their number by subdivision, and thus the leaves expand, and the bud lengthens into a shoot and twig. During the season new buds are formed, and the whole process repeats itself from year to year, giving rise to the ramification and height growth of the tree. The end buds being mostly stronger and better developed, the main axis of tree or branch increases more rapidly than the rest. All these buds originate from the youngest, central part of the shoot, the pith, and hence when the tree grows in thickness, enveloping the base of the limbs, their connection with the pith can always be traced. This is the usual manner of bud formation; in addition, so-called "adventitious" buds may be formed from the young living wood in later life, which are not connected with the pith. Such buds are those which develop into sprouts from the stump when the tree is cut; also those which give rise to what are known as "water sprouts." Many buds, although formed, are, however, not developed at once, and perhaps not at all, especially as the tree grows older; these either die or remain "dormant," often for a hundred years, to spring into life when necessary.

The fact that each ordinary limb starts as a bud from the pith is an important one to the timber grower; it explains knotty timber and gives him the hint that in order to obtain clear timber the branches first formed must be soon removed, either by the knife or by proper shading, which kills the branches and thus "clears" the shaft. The planter has it also in his power to influence the form development of the tree by removing some of the buds, giving thereby better chance to the remaining ones. This pruning of buds is, where practicable, often better practice than the pruning of limbs.

Since the tree does not grow in length except by its buds it is evident that a limb which started to grow at the height of 6 feet has its base always 6 feet from the ground, and if allowed to grow to size, must be surrounded by the wood which accumulates on the main stem or trunk. If a limb is killed and broken off early, only a slender stub composed entirely of rapidly decaying sapwood, is left, occasioning, therefore, only a small defect in the heart of the tree; but if left to grow to considerable age, the base of the limb is incased by the wood of the stem, which, when the tree is cut into lumber, appears as a knot. The longer the limb has been allowed to grow, the farther out is the timber knotty and the thicker is the knot. If the limb remains alive, the knot is "sound," losely grown together with the fibers of the tree. If the limb died off, the remaining stub may behave in different ways. In pines it will be largely composed of heartwod, very resinous and durable; separated from the fibers of the overgrowing wood, it forms a "loose" knot, which is apt to fall out of a board, leaving a hole.

In broad-leaved trees, where no resin assists in the process of healing, the stub is apt to decay, and this decay, caused by the growth of fungi, is apt to penetrate into the tree. In parks and orchards, pruning is resorted to, and the cuts are painted or tarred to avoid the decay. In well-managed forests and dense woods in general, the light is cut off, the limb is killed when young and breaks away, the shaft "clears itself," and the sound trunk furnishes a good grade of material. The difference in development of the branch system, whether in full enjoyment of light, in open stand, or with the side light cut off, in dense position, is very apparent.

Both trees start alike; the one retains its branches, the other loses them gradually, the stubs being in time overgrown; finally the second has a clear shaft, with a crown concentrated at the top, while the first is beset with branches and branch stubs for its whole length. Since the branches grow in more or less regular whorls, several knots, stumps, or limbs are met every 6 to 24 inches.

Hence, in forest planting, trees are placed and kept for some time close together, in order to decrease the branching in the lower part of the tree and thus produce a clean bole and clear lumber.

Growth in Thickness.—The young seedling and the young shoot of the older tree much resemble in interior structure that of any herbaceous plant, being composed of a large amount of pith, loose squarish cells, and a few bundles of long fibers symmetrically distributed about the center, the whole covered with a thin skin or epidermis. Each strand or bundle of fibers, called fibro-vascular (fiber-vessel) bundles, consists of two kinds, namely, wood fibers on the inner side and bast fibers of different structure on the outer side. Between these two sets of fibers, the bast and the wood, there is a row of cells which form the really active, growing part of the plantlet, the cambium. The cambium cells are actively subdividing and expanding, giving off wood cells to the interior and bast cells to the exterior, and extending at the same time sidewise, until at the end of the season not only are the wood and bast portions increased in lines radiating from the center, but the cambium layer, the wood cells, and the bast cells of all the bundles (scattered at the beginning) join at the sides to form a complete ring, or rather hollow cylinder, around the central pith. Only here and there the pith cells remain, interrupting the wood cylinder and giving rise to the system of cells known as medullary rays. The cross section now shows a comparatively small amount of pith and bast or bark and a larger body of strong wood fibers. The new shoot at the end, to be sure, has the same appearance and arrangement as the young plantlet had, the pith preponderating, and the continuous cylinder of cambium, bast, and wood being separated into strands or bundles.

During the season, through the activity of the cambial part of the bundles, the same changes take place in the new shoot as did the previous year in the young seedling, while at the same time the cambium in the yearling part also actively subdivides, forming new wood and bast cells, and thus a second ring, or rather cylinder, is formed. The cambium of the young shoot is always a continuation of that of the ring or cylinder formed the year before, and this cambium cylinder always keeps moving outward, so that at the end of the season, when activity ceases, it is always the last minute layer of cells on the outside of the wood, between wood proper and bark. It is here, therefore, that the life of the tree lies, and any injury to the cambium must interfere with the growth and life of the tree.

The first wood cells which the cambium forms in the spring are usually or always of a more open structure, thin walled, and with a large opening or "lumen," comparable to a blown-up paper bag; so large, in fact, sometimes, is the "lumen" that the width of the cells can be seen on a cross section with the naked eye, as, for instance, in oak, ash, elm, the so-called "pores" are this open wood formed in spring. The cells, which are formed later in summer, have mostly thick walls, are closely crowded and compressed, and show a very small opening or "lumen," being comparable, perhaps, to a very thick wooden box. They appear in the cross section not only denser but of a deeper color, on account of their crowded, compressed condition and thicker walls. Since at the beginning of the next season again thin-walled cells with wide openings or lumina are formed, this difference in the appearance of "spring wood" and "summer wood" enables us to distinguish the layer of wood formed each year. This "annual ring" is more conspicuous in some kinds than in others. In the so-called "ring porous" woods, like oak, ash, elm, the rings are easily distinguished by the open spring wood; in the conifers, especially pines, by the dark-colored summer wood; while in maple, birch, tulip, etc., only a thin line of flattened, hence darker and regularly aligned, summer cells, often hardly recognizable, distinguishes the rings from each other. Cutting through a tree, therefore, we can not only ascertain its age by counting its annual layers in the cross section, but also determine how much wood is formed each year. We can, in fact, retrace the history of its growth, the vicissitudes through which it has passed, by the record preserved in its ring growth.

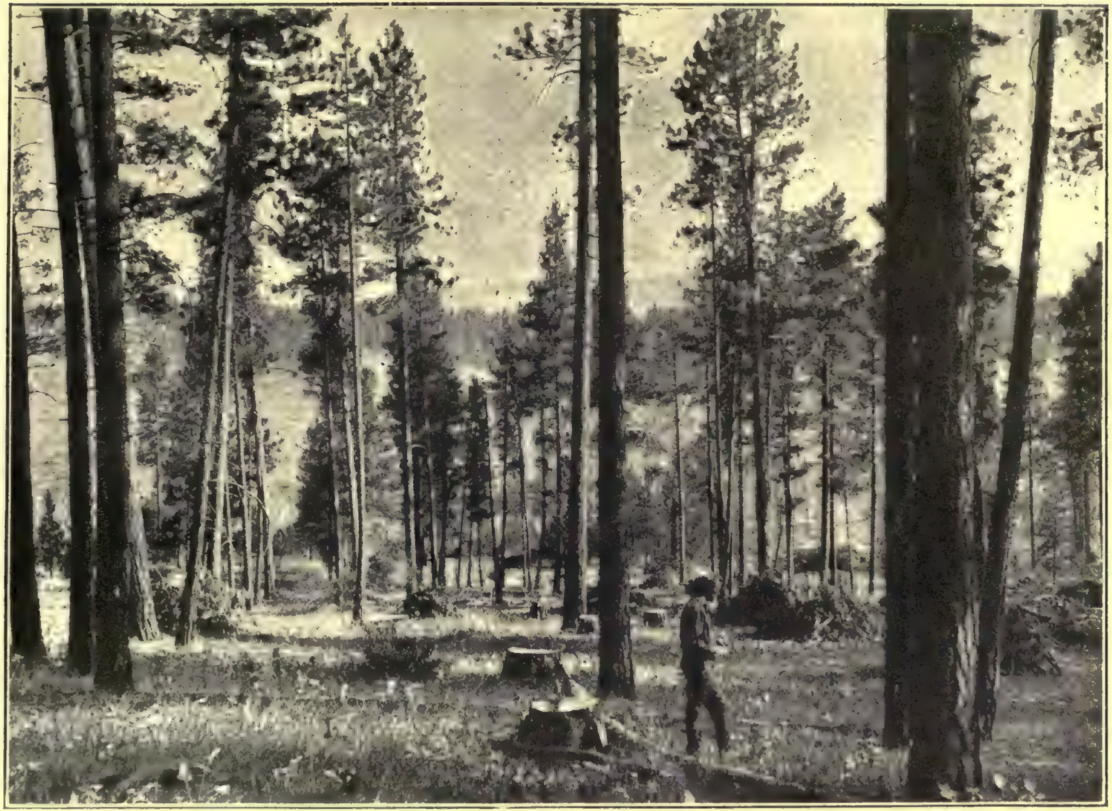
To ascertain the age of a tree correctly, however, we must cut so near to the ground as to include the growth of the first year's little plantlet; any section higher up shows as many years too few as it took the tree to reach that height.

This annual-ring formation is the rule in all countries which have distinct seasons of summer and winter and temporary cessation of growth. Only exceptionally a tree may fail to make its growth throughout its whole length on account of loss of foliage or other causes; and occasionally when its growth has been disturbed during the season, a "secondary" ring, resembling the annual ring, and distinguishable only by the expert, may appear and mar the record.

To the forest planter this chapter on ring growth is of great importance, because not only does this feature of tree life afford the means of watching the progress of his crop, calculating the amount of wood formed, and there-from determining when it is most profitable for him to harvest (namely, when the annual or periodic wood growth falls below a certain amount), but since the proportion of summer wood and spring wood determines largely the quality of the timber, and since he has it in his power to influence the preponderance of the one or other by adaptation of species to soils and by their management, ring growth furnishes an index for regulating the quality of his crop.

Form Development.—If a tree is allowed to grow in the open, it has a tendency to branch, and makes a low and spreading crown. In order to lengthen its shaft and to reduce the number of branches it is necessary to narrow its growing space, to shade its sides so that the lower branches and their foliage do not receive light enough to perform their functions. When the side shade is dense enough, these branches die and finally break off under the influence of winds and fungous growth; wood then forms over the scars and we get a clean shaft which carries a crown high up beyond the reach of shade from neighbors.

The branches being prevented from spreading out, the shaft is forced to grow upward, and hence, when crowded by others, trees become taller and more cylindrical in form, while in the open where they can spread, they remain lower and more conical in form.



Good Work in Piling Brush.

There are, to be sure, different natural types of development, some, like the walnuts, oaks, beeches, and the broad-leafed trees generally, having greater tendency to spread than others, like spruces, firs, and conifers in general, which lengthen their shaft in preference to spreading, even in the open. This tendency to spreading is also influenced by soil conditions and climate, as well as by the age of the tree. When the trees cease to grow in height, their crowns broaden, and this takes place sooner in shallow soils than in deep, moist ones; but the tendency can be checked and all can be made to develop the shaft at the expense of the branches by proper shading from the sides.

It follows that the forest planter, who desires to produce long and clean shafts and best working quality of timber, must secure and maintain side shade by a close stand, while the landscape gardener, who desires characteristic form, must maintain an open stand and full enjoyment of light for his trees.

Now, as we have seen, different species afford different amounts of shade, and in proportion to the shade which they afford can they endure shade. The beech or sugar maple or spruce, which maintain a large amount of foliage under the dense shade of their own crown, show that their leaves can live and functionate with a small amount of light. They are shade-enduring trees. On the other hand, the black walnut, the locust, the catalpa, the poplars, and the larch show by the manner in which their crowns thin out, the foliage being confined to the ends of the branches, that their leaves require more light—they are light-needing trees; so that the scale which arranges the trees according to the amount of shade they exert serves also to measure their shade endurance. In making, therefore, mixed plantations, the different kinds must be so grouped and managed that the shady trees will not outgrow and overtop the light-needing; the latter must either have the start of the former or must be quicker growers.

Rate of Growth.—Not only do different species grow more or less rapidly in height and girth, but there is in each species a difference in the rate of growth during different periods of life, and a difference in the persistence of growth. It stands to reason that trees grow differently in different soils and situations, and hence we can not compare different species with respect to their rate of growth except as they grow under the same conditions.

Thus the black walnut may grow as fast as or faster than the ash on a rich, deep, moist, warm soil, but will soon fall to the rear in a wetter, colder, and shallower soil.

Given the same conditions, some species will start on a rapid upward growth at once, like the poplars, aspen, locust, and silver maple, making rapid progress (the most rapid from their tenth to their fifteenth year), but decreasing soon in rate and reaching their maximum height early. Others, like the spruce, beech, and sugar maple, will begin slowly, often occupying several, sometimes as many as 10 to 15 years before they appear to grow at all, their energy all going into root growth. Then comes a period of more and more accelerated growth, which reaches its maximum rate at 25 or 30 years; and when the cottonwood or aspen has reached the end of its growth in height the spruce or pine is still at its best rate, and continues to grow for a long time at that rate; in later life the rate decreases, yet height growth sometimes does not cease altogether for centuries. As a rule, the light-needing species are the ones which show the rapid height growth at the start, while the shade-enduring are slow at the start, but persistent growers.

This fact is important in explaining the alternations of forest growth in nature; the persistent shade-enduring species crowd out the light-needing, and the latter rapidly take possession of any openings that fire or storm has made. It is also important with reference to the management of wood crops and starting of mixed plantations; the light-needing species must be mixed only with such shade-enduring species as are slower growers than themselves. The diameter growth shows also periodic changes in its rate, and is, of course, influenced in the same way by soil, climate, and light conditions, as the height growth.

In the juvenile or brush stage, lasting 6 to 10 years in light-needing and 20 to 40 years in shade-enduring species, the diameter grows comparatively little, all energy being directed to height growth and root growth. When the crown has been definitely formed, more food material is available for wood formation, and the increase in foliage is accompanied by a more rapid increase of trunk diameter; in favorable situations, the highest rate occurs between the fortieth and sixtieth years; in the poorer situations, between the fiftieth and eightieth years, which rate continues for some time. Then comes a period of slower rate, which finally in old age dwindles down almost to zero.

But neither the diameter growth nor the width of the annual rings alone tells us directly what amount of wood is forming. The outer rings, being laid over a larger circumference, although thinner than the preceding rings, may yet have greater cubic contents. The statements of diameter growth are, therefore, misleading if we are interested in knowing how much wood is forming.

Accordingly the growth in volume must be considered separately, as determined by the enlargement of the cross-section area and the height. The growth in volume or mass accretion is quite small in young trees, so that when wood is cut young the smallest amount of crop per year is harvested, while, if it is allowed to grow, an increase more than proportionate to the number of years may be obtained. Only when the tree has a fully developed crown does it begin to make much wood. Its volume growth progresses then at compound interest, and continues to do so for decades, and sometimes for a century or more. On poorer sites the rate is slower, but remains longer on the increase, while on good sites the maximum rate is soon reached.

Of course, in a forest, where light conditions are not most favorable, because form development and soil conditions require shade, the total wood formation is less than in an isolated tree, favorably placed. Just so the dominant trees in a forest—i. e., those which have their crowns above all others—show, of course, the advantage they have over the inferior trees which are suffering from the shade of their neighbors.

Finally, if we would take into consideration an entire forest growth, and determine, for instance, how much wood an acre of such forest produces at different periods, we must not overlook the fact that the number of trees per acre changes as the trees grow older. Some of them are overshaded and crowded out by the others, so that a young growth of spruce might start with 100,000 little seedlings to the acre, of which in the twentieth year only 10,000 would be alive, while in the fortieth year the number would be reduced to 1,200, and in the hundredth year to 280. Hence the rate of growth of any single tree gives no idea of what the acre of forest will do.

Thus, while a single good, white pine might grow the fastest in volume when about one hundred years old, then making wood at the rate of, say, 1.5 cubic feet per year, an acre of pine on good soil, containing about 1,600 trees, may make the most wood in the thirtieth year, then growing at the rate of 170 cubic feet per acre, while in the hundredth year the rate would not exceed 70 cubic feet; and an acre of pine in a poorer location, with about 1,400 trees, may make the most wood in the fortieth year, at the rate of 100 cubic feet per acre. From the consideration of the relation of light conditions to soil conditions, to form development, and to rate of growth, we may make the following deductions of interest to the forest planter:

In order to secure the best results in wood production, in quantity and quality, at the same time preserving favorable soil conditions, the forest should be composed of various species, a mixture of light-needing and shade-enduring kinds. The light-needing ones should be of quicker growth; the shady ones, in larger numbers, should be slower growers. For the first fifteen to twenty-five years the plantation should be kept as dense as possible, to secure clear shafts and good growth in height; then it should be thinned, to increase crown development and diameter growth; the thinning, however, is not to be so severe that the crowns can not close up again in two or three years; the thinning is to be repeated again and again, always favoring the best developed trees.

Reproduction.—All trees reproduce themselves naturally from seed. Man can secure their reproduction also from cuttings or layers; and some kinds can reproduce themselves by shoots from the stump when the parent tree has been cut. This latter capacity is possessed in a varying degree by different species; chestnuts, oaks, elms, maples, poplars, and willows are most excellent sprouters; most conifers do not sprout at all, and the shoots of those that do sprout soon die (Sequoia or California redwood seems to be an exception). Sprouts of broad-leafed trees develop differently from seedlings, growing very rapidly at first, but soon lessening in the rate of growth and never attaining the height and perhaps not the diameter of trees grown from the seed; they are also shorter lived. With age the stumps lose their capacity for sprouting. To secure best results, the parent tree should be cut close to the ground in early spring, avoiding severe frost, and a sharp cut should be made which will not sever the bark from the trunk. Not all trees bear seed every year, and plentiful seed production, especially in a forest, occurs, as a rule, periodically. The periods differ with species, climate and season.

Not all seeds can germinate, and in some species the number of seeds that can germinate is very small, and they lose their power of germination when kept a few hours, like the willows. Others, if kept till they have become dry, will "lie over" in the soil a year or more before germinating. The same thing will occur if they are covered too deep in the soil, provided they germinate at all under such conditions.

In order to germinate, seeds must have warmth, air, and moisture. The preparation of a seed bed is, therefore, necessary in order to supply these conditions in most favorable combination. In the natural forest millions of seeds rot or dry without sprouting, and millions of seedlings sprout, but soon perish under the too dense shade of the mother trees. Man, desiring to reproduce a valuable wood crop, can not afford to be as lavish as nature, and must therefore improve upon nature's methods, making more careful preparation for the production of his crop, either by growing the seedlings in nurseries and transplanting them, or else by cutting away the old growth in such a manner as to secure to the young self-grown crop better chances for life and development.

How to Plant a Forest.—Forest planting and tree planting are two different things. The orchardist, who plants for fruit; the landscape gardener, who plants for form; the roadside planter, who plants for shade, all have objects in view different from that of the forest planter, and therefore select and use their plant material differently. They deal with single individual trees, each one by itself destined for a definite purpose. The forester, on the other hand, plants a crop like the farmer; he deals not with the single seed or plant, but with masses of trees; the individual tree has value to him only as a part of the whole. It may come to harvest for its timber, or it may not come to harvest, and yet have answered its purpose as a part of the whole in shading the ground, or acting as nurse or "forwarder" as long as it was necessary. His object is not to grow trees, but to produce wood, the largest amount of the best quality per acre, whether it be stored in one tree or in many, and his methods must be directed to that end.

As far as the manner of setting out plants or sowing seeds is concerned, the same general principles and the same care in manipulation are applicable as in any other planting, except as the cost of operating on so large a scale may necessitate less careful methods than the gardener or nurseryman can afford to apply; the nearer, however, the performance of planting can be brought to the careful manner of the gardener, the surer the success. The principles underlying such methods have been discussed in the chapter "How trees grow;" in the present chapter it is proposed to point out briefly the special considerations which should guide the forest planter in particular.

What Trees to Plant.—Adaptability to climate is the first requisite in the species to be planted. It is best to choose from the native growth of the region which is known to be adapted to it. With regard to species not native, the reliance must be placed upon the experience of neighboring planters and upon experiment (at first on a small scale), after study of the requirements of the kinds proposed for trial. Adaptation must be studied, not only with reference to temperature ranges and rainfall, but especially with reference to atmosphere humidity, requirements of transpiration and height above sea level.

Many species have a wide range of natural distribution, and hence of climatic adaptation. If such are to be used, it is important to secure seeds from that part of the range of natural distribution where the plants must be hardiest, i. e., the coldest and driest region in which it occurs, which insures hardy qualities in the offspring. For instance, the Douglas spruce from the humid and evenly tempered Pacific Slope will not be as hardy as that grown from seed collected on the dry and frigid slopes of the Rockies. Lack of attention to this requisite accounts for many failures. It must also be kept in mind that while species may be able to grow in another than its native climate, its wood may not there have the same valuable qualities which it develops in its native habitat. *Adaptability to soil* must be studied less with reference to mineral constituents than to physical condition. Depth and moisture conditions, and the structure of the soil, which influences the movement of water in it, are the most important elements. While all trees thrive best in a moist to "fresh" soil of moderate depth (from 2 to 4 feet) and granular structure, some can adapt themselves to drier or wetter, shallow, and compact soils. Fissures in rocks into which the roots can penetrate often stand for depth of soil, and usually aid in maintaining favorable moisture conditions. In soils of great depth (i. e., from the surface to the impenetrable subsoil) and of coarse structure water may drain away so fast as not to be available to the roots. Soil moisture must always be studied in conjunction with atmospheric moisture, for, while a species may thrive in an arid soil, when the demands of transpiration are not great, it may not do so when aridity of atmosphere is added. Trees of the swamp are apt to be indifferent to soil moisture and to thrive quite well, if not better, in drier soils.

Adaptability to site.—While a species may be well adapted to the general climatic conditions of a region, and in general to the soil, there still remains to be considered its adaptability to the particular "site," under which term we may comprise the total effect of general climate, local climate, and soil. The general climatic conditions are locally influenced, especially by the slope exposure, or aspect, and the surroundings. Thus we know that eastern exposures are more liable to frost, western exposures more liable to damage from winds, southern more apt to be hot and to dry out, and northern to be cooler and damper, having in consequence a shorter period of vegetation. Hollows and lowlands are more exposed to frosts and more subject to variations in soil moisture, etc. Hence for these various situations it is advisable to select species which can best withstand such local dangers.

The use value, or utility, of the species is next to be considered. This must be done with reference to the commercial and domestic demand, and the length of time it takes the species to attain its value. The greater variety of purposes a wood may serve—i. e., the greater its general utility—and the sooner it attains its use value the better. White pine for the northeastern States as a wood is like the apple among fruits, making an all-round useful material in large quantities per acre in short time. Tulip poplar, applicable to a wider climatic range, is almost as valuable, while oak, ash and hickory are standard woods in the market. Other woods are of limited application. Thus the black locust, which grows most quickly into useful posts, has only a limited market, much more limited than it should have; hickory soon furnishes valuable hoop poles from the thinnings, and later the best wagon material, not, however, large quantities in a short time; while black walnut of good quantity is very high in price, the market is also limited, and the dark color of the heartwood, for which it is prized, is attained only by old trees. The black cherry, used for similar purposes, attains its value much sooner. By planting various species together, variety of usefulness may be secured and the certainty of a market increased.

The forest value of the species is only in part expressed by its use value. As has been shown in another place, the composition of the crop must be such as to insure maintenance of favorable soil conditions, as well as satisfactory development of the crop itself. Some species, although of high use value, like ash, oak, etc., are poor preservers of soil conditions, allowing grass and weeds to enter the plantation and to deteriorate the soil under thin foliage. Others, like beech, sugar maple, box elder, etc., although of less use value, being dense foliaged and preserving a shady crown for a long time, are of great forest value as soil improvers.

Again, as the value of logs depends largely on their freedom from knots, straightness, and length, it is of importance to secure these qualities. Some valuable species, if grown by themselves, make crooked trunks, do not clean their shafts of branches, and are apt to spread rather than lengthen. If planted in close companionship with others, they are forced by these "nurses or forwarders" to make better growths and clean their shafts of branches.

Furthermore, from financial considerations, it is well to know that some species develop more rapidly and produce larger quantities of useful material per acre than others; thus the white pine is a "big cropper," and, combining with this a tolerably good shading quality, and being in addition capable of easy reproduction, it is of highest "forest value." Hence, as the object of forestry is to make money from continued wood crops, use value and forest value must both be considered in the selection of materials for forest planting. Mutual relationship of different species, with reference especially to their relative height growth and their relative light re-requirements, must be considered in starting a mixed plantation.

Mixed forest plantations (made of several kinds) have so many advantages over pure plantations (made of one kind) that they should be preferred, except for very particular reasons. Mixed plantations are capable of producing larger quantities of better and more varied material, preserve soil conditions better, are less liable to damage from winds, fires, and insects, and can be more readily reproduced.

The following general rules should guide in making up the composition of a mixed plantation: *a.* Shade-enduring kinds should form the bulk (five eighths to seven eighths) of the plantation, except on specially favored soils where no deterioration is to be feared from planting only light-needing kinds, and in which case these may even be planted by themselves. *b.* The light-needing trees should be surrounded by shade-enduring of slower growth, so that the former may not be overtopped, but have the necessary light and be forced by side shade to straight growth. *c.* Shade-enduring species may be grown in admixture with each other when their rate of height growth is about equal, or when the slower-growing kind can be protected against the quicker-growing (for instance, by planting a larger proportion of the former in groups or by cutting back the latter). *d.* The more valuable timber trees which are to form the main crop should be so disposed individually, and planted in such numbers among the secondary crop or nurse crop, that the latter can be thinned out first without disturbing the former.

Where a plantation of light-foliaged trees has been made (black walnut, for instance), it can be greatly improved by "underplanting" densely with a shade-enduring kind, which will choke out weed growth, improve the soil, and thereby advance the growth of the plantation. The selection and proper combination of species with references to this mutual relationship to each other and to the soil are the most important elements of success.

Availability of the species also still needs consideration in this country; for, although a species may be very well adapted to the purpose in hand, it may be too difficult to obtain material for planting in quantity or at reasonable prices. While the beech is one of the best species for shade endurance, and hence for soil cover, seedlings can not be had as yet in quantity. Western conifers, although promising good material for forest planting, are at present too high priced for general use. Some eastern trees can be secured readily—either their seed or seedlings—from the native woods; others must be grown in nurseries before they can be placed in the field.

Whether to procure seeds or plants, and if the latter, what kind, depends upon a number of considerations. The main crop, that which is to furnish the better timber, had best be planted with nursery-grown plants, if of slow-growing kinds, perhaps once transplanted, with well-developed root systems, the plants in no case to be more than 2 to 3 years old. The secondary or nurse crop may then be sown or planted with younger and less costly material taken from the woods or grown in seed beds, or else cuttings may be used.

In some localities—for instance, the Western plains—the germinating of seeds in the open field is so uncertain, and the life of the young seedlings for the first year or two so precarious, that the use of seeds in the field can not be recommended. In such locations careful selection and treatment of the planting material according to the hardships which it must encounter can alone insure success. Seedlings from 6 to 12 inches high furnish the best material. The planting of large-sized trees is not excluded, but is expensive and hence often impracticable, besides being less sure of success, since the larger-sized tree is apt to lose a greater proportion of its roots in transplanting.

Methods of Planting.—Preparation of soil is for the purpose of securing a favorable start for the young crop; its effects are lost after the first few years. Most land that is to be devoted to forest planting does not admit of as careful preparation as for agricultural crops, nor is it necessary where the climate is not too severe and the soil not too compact to prevent the young crop from establishing itself. Thousands of acres in Germany are planted annually without any soil preparation, yearling pine seedlings being set with a dibble in the unprepared ground. This absence of preparation is even necessary in sandy soils, like that encountered in the sandhills of Nebraska, which may, if disturbed, be blown out and shifted. In other cases a partial removal of a too rank undergrowth or soil cover and a shallow scarifying or hoeing is resorted to, or else furrows are thrown up and the trees set out in them.

In land that has been tilled, deep plowing (10 to 12 inches) and thorough pulverizing give the best chances for the young crop to start. For special conditions, very dry or very moist situations, special methods are required. The best methods for planting in the semiarid regions of the far West have not yet been devloped. Thorough cultivation, as for agricultural crops, with subsequent culture, is successful, but expensive. A plan which might be tried would consist in breaking the raw prairie in June and turning over a shallow sod, sowing a crop of oats or alfalfa, harvesting it with a high stubble, then opening furrows for planting and leaving the ground between furrows undisturbed, so as to secure the largest amount of drainage into the furrows and a mulch between the rows.

The time for planting depends on climatic and soil conditions and the convenience of the planter. Spring planting is preferable except in southern latitudes, especially in the West, where the winters are severe and the fall apt to be dry, the soil therefore not in favorable condition for planting. The time for fall planting is after the leaves have fallen; for spring planting, before or just when life begins anew. In order to be ready in time for spring planting, it is a good practice to take up the plants in the fall and "heel them in" over winter (covering them, closely packed, in a dry trench of soil). Conifers can be planted later in spring and earlier in fall than broad-leafed trees.

The density of the trees is a matter in which most planters fail. The advantages of close planting lie in the quicker shading of the soil, hence the better preservation of its moisture and improved growth and form development of the crop. These advantages must be balanced against the increased cost of of close planting. The closer the planting, the sooner will the plantation be self-sustaining and the surer the success.

If planted in squares, or, better still, in quincunx order (the trees in every other row alternating at equal distances), which is most desirable on account of the more systematic work possible and the more complete cover which it makes, the distance should not be more than 4 feet, unless for special reasons and conditions, while 2 feet apart is not too close, and still closer planting is done by nature with the best success. The following numbers of trees per acre are required when planting at distances as indicated:

1½ by 1½ feet.....	19,360	2 by 4 feet......	5,445
1½ by 2 feet.....	14,520	3 by 3 feet......	4,840
2 by 2 feet.....	10,890	3 by 4 feet......	3,630
2 by 3 feet.....	7,260	4 by 4 feet......	2,722

To decrease expense, the bulk of the plantation may be made of the cheapest kinds of trees they may serve as soil cover and secondary or nurse crop, the main crop of from 300 to 600 trees to consist of better kinds, and with better planting material, mainly of light-needing species. These should be evenly disposed through the plantation, each closely surrounded by the nurse crop. It is of course, understood that not all trees grow up; a constant change in numbers by the death (or else timely removal) of the overshaded takes place, so that the final crop shows at 100 years a close cover, with hardly 300 trees to the acre.

After-culture is not entirely avoidable, especially under unfavorable climatic conditions, and if the planting was not close enough. Shallow cultivation between the rows is needed to prevent weed growth and to keep the soil open, until it is shaded by the young trees, which may take a year with close planting and two or three years with rows 4 by 4 feet apart, the time varying also with the species. It is rare that a plantation succeeds in all its parts; gaps or fail places occur, as a rule, and must be filled in by additional planting as soon as possible, if of larger extent than can be closed up in a few years by the neighboring growth. When the soil is protected by a complete leaf canopy, the forest crop may be considered as established, and the after-treatment will consist of judicious thinning.

How to Treat the Wood Lot.—In the northeastern States it is the custom to have connected with the farm a piece of virgin woodland, commonly called the wood lot. Its object primarily is to supply the farmer with the firewood, fence material, and such dimension timbers as he may need from time to time for repairs on buildings, wagons, etc.

As a rule, the wood lot occupies, as it ought to, the poorer part of the farm, the rocky or stony, the dry or the wet portions, which are not well fitted for agricultural crops. As a rule, it is treated as it ought not to be, if the intention is to have it serve its purpose continuously; it is cut and culled without regard to its reproduction. As far as firewood supplies go, the careful farmer will first use the dead and dying trees, broken limbs, and leavings, which is quite proper. The careless man avoids the extra labor which such material requires, and takes whatever splits best, no matter whether the material could be used for better purposes or not. When it comes to the cutting of other material, fence rails, posts, or dimension timber, the general rule is to go into the lot and select the best trees of the best kind for the purpose. This looks at first sight like the natural, most practical way of doing. It is the method which the lumberman pursues when he "culls" the forest, and is, from his point of view perhaps, justifiable, for he only desires to secure at once what is most profitable in the forest. But for the farmer, who proposes to use his wood lot continuously for supplies of this kind, it is a method detrimental to his object, and in time it leaves him with a lot of poor, useless timber which encumbers the ground and prevents the growth of a better crop.

Our woods are mostly composed of many species of trees; they are mixed woods. Some of the species are valuable for some special purposes, others are applicable to a variety of purposes, and again others furnish but poor material for anything but firewood, and even for that use they may not be of the best.

Among the most valuable in the northeastern woods we should mention the white pine—king of all—the white ash, white and chestnut oak, hickories, tulip tree, black walnut, and black cherry, the last three being now nearly exhausted; next, spruce and hemlock, red pine, sugar maple, chestnut, various oaks of the black or red oak tribe, several species of ash and birch, black locust; lastly, elms and soft maples, basswood, poplars, and sycamore. Now, by the common practice of culling the best it is evident that gradually all the best trees of the best kinds are taken out, leaving only inferior trees or inferior kinds—the weeds among trees, if one may call them such—and thus the wood lot becomes well-nigh useless.

It does not supply that for which it was intended; the soil, which was of little use for anything but a timber crop before, is still further deteriorated under this treatment, and being compacted by the constant running of cattle, the starting of a crop of seedlings is made nearly impossible. It would not pay to turn it into tillage ground or pasture; the farm has by so much lost in value. In other words, instead of using the interest on his capital, interest and capital have been used up together; the goose that laid the golden egg has been killed. This is not necessary if only a little system is brought into the management of the wood lot and the smallest care is taken to avoid deterioration and secure reproduction.

Improvement Cuttings.—The first care should be to improve the crop in its composition. Instead of culling it of its best material, it should be culled of its weeds, the poor kinds, which we do not care to reproduce, and which, like all other weeds, propagate themselves only too readily. This weeding must not, however, be done all at once, as it could be in a field crop, for in a full-grown piece of woodland each tree has a value, even the weed trees, as soil cover.

The great secret of success in all crop production lies in the regulating of water supplies; the manuring in part and the cultivating entirely, as well as drainage and irrigation, are means to this end. In forestry these means are usually not practicable, and hence other means are resorted to. The principal of these is to keep the soil as much as possible under cover, either by the shade which the foliage of the tall trees furnishes, or by that from the underbrush, or by the litter which accumulates and in decaying forms a humus cover, a most excellent mulch.

A combination of these three conditions, viz., a dense crown cover, woody underbrush where the crown cover is interrupted, and a heavy layer of well-decomposed humus, gives the best result. Under such conditions, first of all, the rain, being intercepted by the foliage and litter, reaches the ground only gradually, and therefore does not compact the soil as it does in the open field, but leaves it granular and open, so that the water can readily penetrate and move in the soil. Secondly, the surface evaporation is considerably reduced by the shade and lack of air circulation in the dense woods, so that more moisture remains for the use of the trees. When the shade of the crowns overhead (the so-called "crown cover," or "canopy") is perfect, but little undergrowth will be seen; but where the crown cover is interrupted or imperfect, an undergrowth will appear. If this is composed of young trees, or even shrubs, it is an advantage, but if of weeds, and especially grass, it is a misfortune, because these transpire a great deal more water than the woody plants and allow the soil to deteriorate in structure and therefore in water capacity.

Some weeds and grasses, to be sure, are capable of existing where but little light reaches the soil. When they appear it is a sign to the forester that he must be careful not to thin out the crown cover any more. When the more light-needing weeds and grasses appear it is a sign that too much light reaches the ground, and that the soil is already deteriorated. If this state continues, the heavy drain which the transpiration of these weeds makes upon the soil moisture, without any appreciable conservative action by their shade, will injure the soil still further.

The overhead shade or crown cover may be imperfect because there are not enough trees on the ground to close up the interspaces with their crowns, or else because the kinds of trees which make up the forest do not yield much shade; thus it can easily be observed that a beech, a sugar maple, a hemlock, is so densely foliaged that but little light reaches the soil through its crown canopy, while an ash, an oak, a larch, when full grown, in the forest, allows a good deal of light to penetrate.

Hence, in our weeding process for the improvement of the wood crop, we must be careful not to interrupt the crown cover too much, and thereby deteriorate the soil conditions. And for the same reason, in the selection of the kinds that are to be left or to be taken out, we shall not only consider their use value but also their shading value trying to bring about such a mixture of shady and less shady kinds as will insure a continuously satisfactory crown cover, the shade enduring kinds to occupy the lower stratum in the crown canopy, and to be more numerous than the light-needing.

The forester, therefore, watches first the conditions of his soil cover, and his next care is for the condition of the overhead shade, the "crown cover;" for a change in the condition of the latter brings change into his soil conditions, and inversely, from the changes in the plant cover of the soil he judges whether he may or may not change the light conditions. The changes of the soil cover teach him more often when "to let alone" than when to go on with his operations of thinning out, that is to say, he can rarely stop short of that condition which is most favorable. Hence the improvement cuttings must be made with caution and only very gradually, so that no deterioration of the soil conditions be invited. We have repeated this injunction again and again, because all success in the management of future wood crops depends upon the care bestowed upon the maintenance of favorable soil conditions.

As the object of this weeding is not only to remove the undesirable kinds from the present crop, but to prevent as much as possible their reappearance in subsequent crops, it may be advisable to cut such kinds as sprout readily from the stump in summer time—June or July—when the stumps are likely to die without sprouting. It may take several years' cutting to bring the composition of the main crop into such a condition as to satisfy us.

Methods of Reproducing the Wood Crop.—Then comes the period of utilizing the main crop. As we propose to keep the wood lot as such, and desire to reproduce a satisfactory wood crop in place of the old one, this latter must be cut always with a view to that reproduction. There are various methods pursued for this purpose in large forestry operations which are not parcticable on small areas, especially when these are expected to yield only small amounts of timber, and these little by little as required. It is possible, to be sure, to cut the entire crop and replant a new one, or else to use the ax skillfully and bring about a natural reproduction in a few years; but we want in the present case to lengthen out the period during which the old crop is cut, and hence must resort to other methods. There are three methods practicable.

We may clear narrow strips or bands entirely, expecting the neighboring growth to furnish the seed for covering the strip with a new crop—"the strip method"; or we can take out single trees here and there, relying again on an after-growth from seed shed by the surrounding trees—the "selection method"; or, finally, instead of single trees, we may cut entire groups of trees here and there in the same manner, the gaps to be filled, as in the other cases, with a young crop from the seed of the surrounding trees, and this we may call the "group method."

In *the strip method,* in order to secure sufficient seeding of the cleared strip, the latter must not be so broad that the seed from the neighboring growth can not be carried over it by the wind. In order to get the best results from the carrying power of the wind (as well as to avoid windfalls when the old growth is suddenly opened on the windward side) the strips should be located on the side opposite the prevailing winds. Oaks, beech, hickory, and nut trees in general with heavy seeds will not seed over any considerable breadth of strip, while with maple and ash the breadth may be made twice as great as the height of the timber, and the mother trees with lighter seeds, like spruce and pine, or birch and elm, may be able to cover strips of a breadth of 3 or 4 and even 8 times their height. But such broad strips are hazardous, since with insufficient seed fall, or fail years in the seed, the strip may remain exposed to sun and wind for several years without a good cover and deteriorate. It is safer, therefore, to make the strips no broader than just the height of the neighboring timber, in which case not only has the seed better chance of covering the ground, but the soil and seedlings have more protection from the mother crop. In hilly country the strips must not be made in the direction of the slope, for the water would wash out soil and seed.

Every year, then, or from time to time, a new strip is to be cleared and "regenerated." But if the first strip failed to cover itself satisfactorily, the operation is stopped, for it would be unwise to remove the seed trees further by an additional clearing. Accordingly, this method should be used only where the kinds composing the mother crop are frequent and abundant seeders and give assurance of reseeding the strips quickly and successfully. The other two methods have greater chances of success in that they preserve the soil conditions more surely and there is more assurance of seeding from the neighboring trees on all sides. The selection method, by which single trees are taken out all over the forest, is the same as has been practiced by the farmer and lumberman hitherto, only they have forgotten to look after the young crop. Millions of seed may fall to the ground and germinate, but perish from the excessive shade of the mother trees. If we wish to be successful in establishing a new crop, it will be necessary to be ready with the ax all the time and give light as needed by the young crop. The openings made by taking out single trees are so small that there is great danger of the young crop being lost, or at least impeded in its development, because it is impracticable to come in time to its relief with the ax.

The best methods, therefore, in all respects, is the *"group method,"* which not only secures continuous soil cover, chances for full seeding, and more satisfactory light conditions, but requires less careful attention, or at least permits more freedom of movement and adaptation to local conditions.

It is especially adapted to mixed woods, as it permits securing for each species the most desirable light conditions by making the openings larger or smaller, according as the species we wish to favor in a particular group demand more or less shade. Further, when different species are ripe for regeneration at different times, this plan makes it possible to take them in hand as needed. Again, we can begin with one group or we can take in hand several groups simultaneously, as may be desirable and practicable.

We start our groups of new crop either where a young growth is already on the ground, enlarging around it, or where old timber has reached its highest usefulness and should be cut in order that we may not lose the larger growth which young trees would make; or else we choose a place which is but poorly stocked, where, if it is not regenerated, the soil is likely to deteriorate further. The choice is affected further by the consideration that dry situations should be taken in hand earlier than those in which the soil and site are more favorable, and that some species reach maturity and highest use value earlier than others and should therefore be reproduced earlier. In short, we begin the regeneration when and where the necessity for it exists, or where the young crop has the best chance to start most satisfactorily with the least artificial aid. Of course, advantage should be taken of the occurrence of seed years, which come at different intervals with different species.

If we begin with a group of young growth already on the ground, our plan is to remove gradually the old trees standing over them when no longer required for shade, and then cut away the adjoining old growth and enlarge the opening in successive narrow bands around the young growth. When the first band has seeded itself satisfactorily, and the young growth has come to require more light (which may take several years), we remove another band around it, and thus the regeneration progresses. Where no young growth already exists, of course the first opening is made to afford a start, and afterwards the enlargement follows as occasion requires.

Size of Openings.—The size of openings and the rapidity with which they should be enlarged vary, of course, with local conditions and the species which is to be favored, the light-needing species requiring larger openings and quicker light additions than the shade-enduring. It is difficult to give any rules, since the modifications due to local conditions are so manifold, requiring observation and judgment. Caution in not opening too much at a time and too quickly may avoid failure in securing good stands. In general, the first openings may contain from one-fourth to one-half an acre or more, and the gradual enlarging may progress by clearing bands of a breadth not to exceed the height of the surrounding timber.

The time of the year when the cutting is to be done is naturally in winter, when the farmer has the most leisure, and when the wood seasons best after felling and is also most readily moved. Since it is expected that the seed fallen in the autumn will sprout in the spring, all wood should, of course, be removed from the seed ground. The first opening, as well as the enlargement of the groups, should not be made at once, but by gradual thinning out, if the soil is not in good condition to receive and germinate the seed and it is impracticable to put it in such condition by artificial means—hoeing or plowing.

It is, of course, quite practicable—nay, sometimes very desirable—to prepare the soil for the reception and germination of the seed. Where undesirable undergrowth has started, it should be cut out, and where the soil is deteriorated with weed growth or compacted by the tramping of cattle, it should be hoed or otherwise scarified, so that the seed may find favorable conditions. To let pigs do the plowing and the covering of acorns is not an uncommon practice abroad. It is also quite proper, if the reproduction from the seed of the surrounding mother trees does not progress satisfactorily, to assist, when an opportunity is afforded, by planting such desirable species as were or were not in the composition of the original crop.

It may require ten, twenty, or forty years or more to secure the reproduction of a wood lot in this way. A new growth, denser and better than the old, with timber of varying age, will be the result.

Wind Mantle.—A strip should surround the farmer's wood lot, which he should keep as dense as possible, especially favoring undergrowth. This part, if practicable, should be kept reproduced as coppice or by the method of selection, i. e., by taking out trees here and there. When gaps are made, they should be filled, if possible, by introducing shade-enduring kinds, which, like the spruces and firs and beech, retain their branches down to the foot for a long time. This mantle is intended to protect the interior against the drying influence of winds, which are bound to enter the small wood lot and deteriorate the soil. The smaller the lot, the more necessary and desirable it is to maintain such a protective cover or windbreak.

Coppice.—Besides reproducing a wood crop from the seed of mother trees or by planting, there is another reproduction possibly by sprouts from the stump. This, to be sure, can be done only with broad-leafed species, since conifers, with but few exceptions, do not sprout from the stump. When a wood lot is cut over and over again, the reproduction taking place by such sprouts we call coppice.

Most wooded areas in the Eastern States have been so cut that reproduction from seed could not take place, and hence we have large areas of coppice, with very few seedling trees interspersed. Sprouts do not develop into as good trees as the seedlings. They grow faster, to be sure, in the beginning, but do not grow as tall and are apt to be shorter lived.

For the production of firewood, fence, and post material, coppice management may suffice, but not for dimension timber. And even to keep the coppice in good reproductive condition, care should be taken to secure a certain proportion of seedling trees, since the old stumps, after repeated cutting, fail to sprout and die out. Soil and climate influence the success of the coppice; shallow soils produce weaker but more numerous sprouts and are more readily deteriorated by the repeated laying bare of the soil; a mild climate is most favorable to a continuance of the reproductive power of the stump.

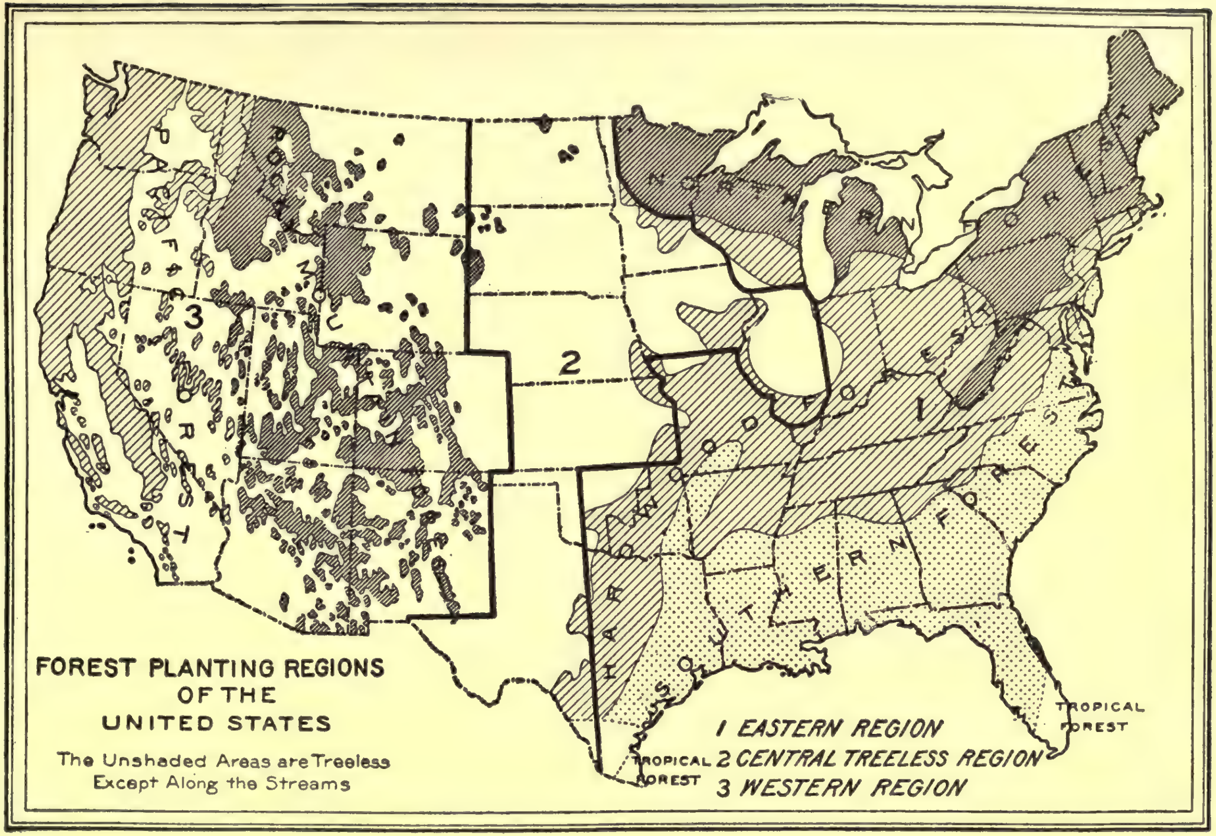
Some species sprout more readily than others; hence the composition of the crop will change, unless attention is paid to it. In the coppice, as in any other management of a natural wood crop, a desirable composition must first be secured, which is done by timely improvement cuttings, as described in a previous section. The best trees for coppice in the northeastern States are the chestnut, various oaks, hickory, ash, elm, maples, basswood, and black locust, which are all good sprouters.

When cutting is done for reproduction, the time and manner are the main care. The best results are probably obtained, both financially and with regard to satisfactory reproduction, when the coppice is cut between the twentieth and thirtieth years. All cutting must be done in early spring or in winter, avoiding, however, days of severe frost, which is apt to sever the bark from the trunk and to kill the cambium. Cutting in summer kills the stump as a rule. The cut should be made slanting downward, and as smooth as possible, to prevent collection of moisture on the stump and the resulting decay, and as close as possible to the ground, where the stump is less exposed to injuries, and the new sprouts, starting close to the ground, may strike independent roots.

Fail places or gaps should be filled by planting. This can be readily done by bending to the ground some of the neighboring sprouts, when 2 to 3 years old, notching, fastening them down with a wooden hook or a stone, and covering them with soil a short distance (4 to 6 inches) from the end. The sprout will then strike root, and after a year or so may be severed from the mother stock by a sharp cut.

For the recuperation of the crop, it is desirable to maintain a supply of seedling trees, which may be secured either by the natural seeding of a few mother trees of the old crop which are left, or by planting. This kind of management, coppice with seedling or standard trees intermixed, if the latter are left regularly and well distributed over the wood lot, leads to a management called "standard coppice." In this it is attempted to avoid the drawbacks of the coppice, viz., failure to produce dimension material and running out of the stocks. The former object is, however, only partially accomplished, as the trees grown without sufficient side shading are apt to produce branchy boles and hence knotty timber, besides injuring the coppice by their shade.

Plan of Management.—In order to harmonize the requirements of the wood lot from a sylvi-cultural point of view, and the needs of the farmer for wood supplies, the cutting must follow some systematic plan. The improvement cuttings need not, in point of time, have been made all over the lot before beginning the cuttings for regeneration, provided they have been made in those parts which are to be regenerated. Both the cuttings may go on simultaneously, and this enables the farmer to gauge the amount of cutting to his consumption. According to the amount of wood



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The Unshaded Areas are Treeless Except Along the Streams

needed, one or more groups may be started at the same time. It is, however, desirable, for the sake of renewing the crop systematically, to arrange the groups in a regular order over the lot.

How to Cultivate the Wood Crop.—Where only firewood is desired, i. e., wood without special form, size, or quality, no attention to the crop is necessary, except to insure that it covers the ground completely. Nevertheless, even in such a crop, which is usually managed as coppice, some of the operations described in this chapter may prove advantageous. Where, however, not only quantity but useful quality of the crop is also to be secured, the development of the wood crop may be advantageously influenced by controlling the supply of light available to the individual trees.

It may be proper to repeat here briefly what has been explained in previous pages regarding the influence of light on tree devlopment.

Effect of Light on Wood Production.—Dense shade preserves soil moisture, the most essential element for wood production; a close stand of suitable kinds of trees secures this shading and prevents the surface evaporation of soil moisture, making it available for wood production. But a close stand also cuts off side light and confines the lateral growing space, and hence prevents the development of side branches and forces the growth energy of the soil to expend itself in height growth; the crown is carried up, and long, cylindrical shafts, clear of branches, are developed; a close stand thus secures desirable form and quality. Yet, since the quality of wood production or accretion (other things being equal) is in direct proportion to the amount of foliage and the available light, and since an open position promotes the development of a larger crown and of more foliage, an open stand tends to secure a larger amount of wood accretion on each tree. On the other hand, a tree grown in the open, besides producing more branches, deposits a larger proportion of wood at the base, so that the shape of the bole becomes more conical, a form which in sawing proves unprofitable; whereas a tree grown in the dense forest both lengthens its shaft at the expense of branch growth and makes a more even deposit of wood over the whole trunk, thus attaining a more cylindrical form. While, then, the total amount of wood production per acre may be as large in a close stand of trees as in an open one (within limits), the distribution of this amount among a larger or smaller number of individual trees produces different results in the quality of the crop. And since the size of a tree or log is important in determining its usefulness and value, the sooner the individual trees reach useful size, without suffering in other points of quality, the more profitable the whole crop.

Number of Trees Per Acre.—The care of the forester, then, should be to maintain the smallest number of individuals on the ground which will secure the greatest amount of wood growth in the most desirable form of which the soil and climate are capable, without deteriorating the soil conditions. He tries to secure the most advantageous individual development of single trees without suffering the disadvantages resulting from too open stand. The solution of this problem requires the greatest skill and judgment, and rules can hardly be formulated with precision, since for every species or combination of species and conditions these rules must be modified. In a well-established young crop the number of seedlings per acre varies greatly, from 3,000 to 100,000, according to soil, species, and the manner in which it originated, whether planted, sown or seeded naturally. Left to themselves, the seedlings, as they develop, begin to crowd each other. At first this crowding results only in increasing the height growth and in preventing the spread and full development of side branches; by and by the lower branches failing to receive sufficient light finally die and break off—the shaft "clears itself." Then a distinct development of definite crowns takes place, and after some years a difference of height growth in different individuals becomes marked. Not a few trees fail to reach the general upper crown surface, and, being more or less overtopped, we can readily classify them according to height and development of crown, the superior or "dominating" ones growing more and more vigorously, the inferior or "dominated" trees falling more and more behind, and finally dying for lack of light, and thus a natural reduction in numbers, or thinning, takes place. This natural thinning goes on with varying rates at different ages, continuing through the entire life of the crop, so that, while only 4,000 trees per acre may be required in the tenth year to make a dense crown cover or normally close stand, untouched by man, in the fortieth year 1,200 would suffice to make the same dense cover, in the eightieth year 350 would be a full stand, and in the one hundredth not more than 250, according to soil and species, more or less. As we can discern three stages in the development of a single tree—the juvenile, adolescent, and mature—so, in the development of a forest growth, we may distinguish three corresponding stages, namely, the "thicket" or brushwood, the "pole-wood" or sapling, and the "timber" stage. During the thicket stage, in which the trees have a bushy appearance, allowing hardly any distinction of stem and crown, the height growth is most rapid. This period may last, according to conditions and species, from 5 or 10 to 30 and even 40 years—longer on poor soils and with shade-enduring species, shorter with light-needing species on good soils—and, while it lasts, it is in the interest of the wood grower to maintain the close stand, which produces the long shaft, clear of branches, on which at a later period the wood that makes valuable, clear timber, may accumulate. Form development is now most important. The lower branches are to die and break off before they become too large. With light-needing species and with deciduous trees generally this dying off is accomplished more easily than with conifers. The spruces and even the white pine require very dense shading to "clear" the shaft. During this period it is only necessary to weed out the undesirable kinds, such as trees infested by insect and fungus, shrubs, sickly, stunted, or bushy trees which are apt to overtop and prevent the development of their better neighbors. In short, attention is now devoted mainly to improving the composition of the crop.

Weeding and Cleaning the Crop.—This weeding or cleaning is easily done with shears when the crop is from 3 to 5 years old. Later, mere cutting back of the undesirable trees with a knife or hatchet may be practiced. In well-made artificial plantations this weeding is rarely needed until about the eighth or tenth year. But in natural growths the young crop is sometimes so dense as to inordinately interfere with the development of the individual trees. The stems then remain so slender that there is danger of their being bent or broken by storm or snow when the growth is thinned out later. In such cases timely thinning is indicated to stimulate more rapid development of the rest of the crop. This can be done most cheaply by cutting swaths or lanes one yard wide and as far apart through the crop, leaving strips standing. The outer trees of the strip, at least, will then shoot ahead and become the main crop. These weeding or improvement cuttings, which must be made gradually and be repeated every two or three years, are best performed during the summer months, or in August and September, when it is easy to judge what should be taken out.

Methods of Thinning.—During the "thicket" stage, then, which may last from 10 to 25 and more years, the crop is gradually brought into proper composition and condition. When the "pole-wood" stage is reached, most of the saplings being now from 3 to 6 inches in diameter and from 15 to 25 feet in height, the variation in sizes and in appearance becomes more and more marked. Some of the taller trees begin to show a long, clear shaft and a definite crown. The trees can be more or less readily classified into height and size classes. The rate at which the height growth has progressed begins to fall off and diameter growth increases. Now comes the time when attention must be given to increasing this diameter growth by reducing the number of individuals and thus having all the wood which the soil can produce deposited on fewer individuals. This is done by judicious and often repeated thinning, taking out some of the trees and thereby giving more light and increasing the foliage of those remaining; and as the crowns expand, so do the trunks increase their diameter in direct proportion. These thinnings must, however, be made cautiously lest at the same time the soil is exposed too much, or the branch growth of those trees which are to become timber wood is too much stimulated. So varying are the conditions to be considered, according to soil, site, species, and development of the crop, that it is well-nigh impossible, without a long and detailed discussion, to lay down rules for the proper procedure. In addition the opinions of authorities differ largely both as to manner and degree of thinning, the old school advising moderate, and the new school severer thinnings.

For the farmer, who can give personal attention to detail and whose object is to grow a variety of sizes and kinds of wood, the following general method may perhaps be most useful:

First determine which trees are to be treated as the main crop or "final harvest" crop. For this 300 to 500 trees per acre of the best grown and most useful kinds may be selected, which should be distributed as uniformly as possible over the acre. These, then—or as many as may live till the final harvest—are destined to grow into timber and are to form the special favorites as much as possible. They may at first be marked to insure recognition; later on they will be readily distinguished by their superior development. The rest, which we will call the "subordinate" crop, is then to serve merely as filler, nurse, and soil cover.

What Trees to Remove.—It is now necessary, by careful observation of the surroundings of each of the "final harvest" crop trees, or "superiors," as we may call them, to determine what trees of the "subordinate" crop trees, or "inferiors," must be removed. All nurse trees that threaten to overtop the superiors must either be cut out or cut back and topped, if that is practicable, so that the crown of the superiors can develop freely. Those that are only narrowing in the superiors from the side, without preventing their free top development, need not be interfered with, especially while they are still useful in preventing the formation and spreading of side branches on the superiors. As soon as the latter have fully cleared their shafts, these crowding inferiors must be removed. Care must be taken, however, not to remove too many at a time, thus opening the crown cover too severely and thereby exposing the soil to the drying influence of the sun. Gradually, as the crowns of inferiors standing farther away begin to interfere with those of the superiors, the inferiors are removed, and thus the full effect of the light is secured in the accretion of the main harvest crop; at the same time the branch growth has been prevented and the soil has been kept shaded. Meanwhile thinnings may also be made in the subordinate crop, in order to secure also the most material from this part of the crop. This is done by cutting out all trees that threaten to be killed by their neighbors. In this way many a useful stick is saved and the dead material, only good for firewood, lessened. It is evident that trees which in the struggle for existence have fallen behind, so as to be overtopped by their neighbors, can not, either by their presence or by their removal, influence the remaining growth. They are removed only in order to utilize their wood before it decays.

It may be well to remark again that an undergrowth of woody plants interferes in no way with the development of the main crop, but, on the contrary, aids by its shade in preserving favorable moisture conditions. Its existence, however, shows in most cases that the crown cover is not as dense as it should be, and hence that thinning is not required. Grass and weed growth, on the other hand, is emphatically disadvantageous and shows that the crown cover is dangerously open.

The answer to the three questions, When to begin the thinnings, How severely to thin, and How often to repeat the operation, must always depend upon the varying appearance of the growth and the necessities in each case. The first necessity for interference may arise with light-needing species as early as the twelfth or fifteenth year; with shade-enduring, not before the twentieth or twenty-fifth year. The necessary severity of the thinning and the repetition are somewhat interdependent. It is better to thin carefully and repeat the operation oftener than to open up so severely at once as to jeopardize the soil conditions. Especially in younger growths and on poorer soil, it is best never to open a continuous crown cover so that it could not close up again within 3 to 5 years; rather repeat the operation oftener. Later, when the trees have attained heights of 50 to 60 feet and clear boles (which may be in 40 to 50 years, according to soil and kind) the thinning may be more severe, so as to require repetition only every 6 to 10 years.

The condition of the crown cover, then, is the criterion which directs the ax. As soon as the crowns again touch or interlace, the time has arrived to thin again. In mixed growths it must not be overlooked that light-needing species must be specially protected against shadier neighbors. Shade-enduring trees, such as the spruces, beech, sugar maple, and hickories, bear overtopping for a time and will then grow vigorously when more light is given, while light-needing species, like the pines, larch, oaks, and ash, when once suppressed, may never be able to recover. Particular attention is called to the necessity of leaving a rather denser "wind mantle" all around small groves. In this part of the grove the thinning must be less severe, unless coniferous trees on the outside can be encouraged by severe thinning to hold their branches low down, thus increasing their value as windbreaks.

The thinnings, then, while giving to the "final harvest" crop all the advantage of light for promoting its rapid development into serviceable timber size, furnish also better material from the subordinate crop. At 60 to 70 years of age the latter may have been entirely removed and only the originally selected "superiors" remain on the ground, or as many of them as have not died and been removed; 250 to 400 of these per acre will make a perfect stand of most valuable form and size, ready for the final harvest, which should be made as indicated in the preceding chapter.—(Y. B. 1894.)

THE FARM WOODLOT.

The woodlot is a part of the farm which in too many cases has been neglected and looked upon as of no real value in its relation to the farm. It has furnished the owner with fuel and building material and frequently revenue by the sale of a few logs to the local mill. In many cases, however, the woodlot has not been considered as being a permanent resource or a necessary part of the farm economy.

The following pages take it for granted that the owner desires to make the woodlot a permanent and paying part of the farm.

Ground Fires as Related to the Woodlot.—Fire should never be allowed to run through the woodlot. By burning off the leaf litter and vegetable mould or humus the soil is greatly weakened. The healthy development of the forest tree is dependent upon the humus condition of the soil.

Ground fires also destroy the seed and young growth and make it much more difficult for seeds to germinate in the future. The natural seedbed of humus soil covered with the leaves gives a protected, natural seedbed which is necessary for reproduction.

Ground fires frequently pass through the woods in spring and by the middle of the summer the woods seem to have recovered. This is not the case, for usually large trees, which seem to have bark thick enough to withstand the small amount of heat of a ground fire, are injured in a manner not at once visible to the observer. The heat from a ground fire, which it seems is too small to injure a tree with heavy bark, frequently affects the tree very seriously. The injury is of two kinds.

By burning off the humus and litter the soil is left unprotected so that it lacks moisture during the dry season, as well as weakening the soil in regard to food supply for the trees. Frequently the burning kills the shallow roots or leaves them unprotected.

The living tissue beneath the bark of the tree close to the ground becomes so heated that it is either killed or partly destroyed. The first visible effect may be seen in the form of a fungus growth about the base of the tree. This parasitic fungus gradually weakens the tree, making it subject to insect pests, and finally causing its death, but the real and first cause was the innocent looking ground fire.

Probably one of the most serious hindrances to the proper growth and development in the woodlot has been caused by grazing. There were many, a few years ago, who claimed that grazing did not injure the woodlot.

Experience has shown, however, that grazing must always be injurious. Many examples may be seen where the comparison of grazed and ungrazed woodlots show the result. While the injury is admitted by many, there are those who claim that the woodlot is of more value in protecting the cattle during the heat of the day and giving them pasturage than for wood producing purposes. It is very difficult to compare the rental value of the woodlot used for purposes of pasturage and that of the woodlot used exclusively for wood production. One thing is certain, that to have a permanent woodlot where conditions are favorable for tree growth the stock must be excluded.

Domestic animals are frequently classed as to the amount of injury they inflict on the woodlot. From the standpoint of browsing the degree of injury may be placed in the following order: Goats and sheep, horses, cattle, swine, the first mentioned being the most injurious and the last being least. Injurious effects of allowing stock to run in the woodlot may be discussed in its relation to the soil, the reproduction of young growth and the older trees.

While the effects of grazing on the soil may be least noticeable, it is very important. Destruction of young growth soon opens the woodlot to drying winds which carry off the humus-forming leaves and greatly lessen the moisture content of the soil. Light begins to enter and reach the ground, causing grass and weeds to start which soon develop a stiff sod. Trampling of the soil causes it to become impervious, thus allowing the water to run off rapidly instead of being held in the soil as is the case in normal conditions. After these unfavorable conditions have come to prevail, the tree seeds find it very hard to germinate and soon there is no reproduction taking place.

The leaves and tender branches of the young growth in the woodlot are eagerly browsed by the animals. Some species of trees are less liable to browsing than others. Cattle have been noticed standing in good, fresh clover, greedily devouring the leaves from limbs of Sugar Maple which were thrown into the pasture. Evidently they enjoyed a change in diet.

The trampling of the soil, the destruction of young growth, which should protect the soil from sun and wind, and the formation of an impervious sod, all aid in lessening the vigor of growth of the standing, full grown trees. In this case the injurious effects are scarcely noticeable to the common observer owing to his lack of knowledge as to what healthy tree growth actually means. The annual amount of wood production is far below what it should be when the soil conditions are in an abnormal state from grazing.

Many woodlots contain trees that have not reached maturity, but whose tops are dying. Such trees are spoken of as being stag-headed. Stag-headedness is caused by lack of nourishment and moisture in the soil, a result of grazing.

Weed Trees.—Many woodlots contain a large percentage of weed trees or inferior species. Weed trees such as Ironwood, Hawthorn, and Blue Beech have gradually taken possesion as an undergrowth. Everything seems to favor the development of these species. In cutting operations these trees are seldom disturbed. The stock in grazing prefer the leaves and branches of the better species, thus giving these weed trees another advantage. The seedlings of the Ironwood and Blue Beech seem very hardy and vigorous and can stand a great amount of shade, so that they get an early start in the struggle for possession of the soil. When once the Ironwood has obtained a footing its dense foliage so shades the ground that better species cannot develop beneath it. In many woodlots from seventy-five to eighty per cent of the trees under three inches are made up of Ironwood.

The question of the inferiority of a species is relative and depends on local conditions. Inferior species, as Poplars and Slippery or Red Elm, are often growing on soils which are capable of producing much better species. Then in some cases the woodlot has gradually become filled with Sugar Maple when it might be wise to introduce other species.

Defective and Overmature Trees.—The average woodlot contains many defective and overmature trees. The defective trees are of various descriptions. Trees with old fire scars, trees injured while young by the felling of neighboring trees, trees wantonly scarred by the careless blow of an axe, trees broken and deformed by wind or snow, are all forms which should gradually be removed. Overmature trees frequently show a tendency to become stag-headed and if left standing gradually deteriorate in value. Such trees are a menace to the surrounding growth and frequently in felling destroy more than their own value.

Improvement Cutting.—Cutting operations which aim to overcome the above defects, namely, weed trees, inferior species, defective and overmature trees are spoken of as "improvement cutting." In the farm woodlot all cutting for firewood should be made from such trees. It is not to be understood that it is advisable to go through the woods and cut down all the above mentioned trees without regard to the future of the area thus cut over. The first consideration should be to protect the soil, that is, do not cut down a tree or a group of trees unless you are certain that there will follow another crop. If you do not get reproduction the following season it is almost certain that grass and weeds will come in and the soil will soon lose its valuable character as related to tree growth. Whether you can depend on the area reproducing from the seed of neighboring trees or whether it will be necessary to use artificial means can only be judged by local considerations.

Thin Borders and Open Spots.—The borders of woodlots become thin owing to various factors. This outside portion of the woods is more subject to winds and storms which cause windfalls, dry out the soil and blow away the leaves which should go to form vegetable mould. Frequently the border is overcut, as the owner does not trouble going to the interior of the woods for his fuel, etc. In time the soil deteriorates, grass and weeds follow, and then we have the characteristic border which is neither woodland nor pasture.

The development of large open grassy spots in the woodlot is usually due to the effects of grazing. The old trees have been taken out and the young growth destroyed by the stock until grass has taken possession and formed an impervious sod in which the tree seeds find it impossible to develop. The above conditions may be improved in the case of the thin borders by planting evergreens or coniferous trees about the border in order to form a windbreak. Open spots in the woods if covered with grass could be improved by roughly breaking the sod and allowing the seeds to reach the mineral soil. Such breaking can be done with a disk-harrow or plow. In some cases where there is no young growth to injure, it may be advisable to turn in hogs as they frequently make a good seedbed by their rooting in search of grubs, seeds, etc. These measures are to be adopted when the surrounding trees are bearing seed. If there is little chance of such areas being seeded from neighboring trees or if the owner desires to introduce better species into his woodlot he may resort to planting.

Planting of this nature may be done by using the young plants or by sowing seed. With the exception of nut trees, it will be advisable to use plants rather than seed. Methods of planting the woodlot are similar to the methods of planting described elsewhere. While the general methods are similar, there are many bare spots which may need special attention owing to the small amount of light which is able to reach the ground. When breaking the sod with disk or plow is impracticable it is usually possible to break spots about twelve to fifteen inches square with the mattock. In these spots nuts can be dibbled or plants inserted. The success of planting and the vigor of growth depends on the question of light as well as the condition of the soil. In general the locations that have enough light to allow a development of grass may be successfully filled with young tree growth.

The woodlot should have a definite boundary with a belt of evergreens especially on the side from which the prevailing winds come. Too many woodlots have no definite boundary, but are surrounded by slash. Keep a definite boundary well stocked with trees and soon the woodlot will have every acre productive.

Coppice.—Coppice is a form of growth in the woodlot which is little understood by the average owner. Trees are reproduced from seed, cuttings, suckers and shoots. Coppice growth originates from shoots or suckers developing from the stump or root collar of previous years. These new shoots depend upon the root system of the original tree for nourishment. One-year-old shoots may often be seen which have developed from a Chestnut stump. All native deciduous or hardwood trees have the power of reproducing in this way, especially where trees are cut young and at the proper season. Evergreens, with a few exceptions, as Arborvitæ, never reproduce in this way. Certain species, as Chestnut, Baswood, the Oaks, Elm, Poplar, Birch, and Soft Maples, seem to develop these shoots more freely and vigorously than other species.

To obtain good tree growth of coppice after cutting certain considerations must be given attention. Coppice from overmature trees will not produce strong growth, as the old root system has lost its vigor. Coppice loses its vigor of growth by following the system too far, the third and fourth generations becoming weak and decrepit. In many woodlots dwarfed and stunted growth exists from the above causes. Coppice is best produced by cutting in late winter or early spring. Late fall or early winter cutting often allows frost and moisture to loosen the bark. The coppice shoots originate beneath this outer bark and if it is destroyed there is small chance of shoots developing. In cutting with a view of obtaining coppice, the stump should be cut as closely to the ground as possible. It is desirable to obtain resulting shoots as near the ground as possible. Coppice which originates high up on the stump does not become vigorous. Frequently we find trees in the woodlot with the base partly rotted, and such trees are often of coppice origin. In this case the shoots developed from a high point on the original stump with the result that as the old stump decayed the new coppice growth was left weakened at the point of contact. Coppice loses its vigor of reproducing after a few cuttings. When two or three generations of trees of coppice origin have been taken off it is advisable to endeavor to obtain new growth of seedling origin Nuts may be dibbled in where favorable spots can be found, or planting may be resorted to if desired. In any case the area should be gradually restocked with trees of seedling origin.—(Ont. A. C. B. 155.)

FOREST TREE PLANTING IN RELATION TO THE FARM.

The planting of forest trees for wood crop production and for soil protection has been carried on for many years in older countries, as Switzerland, France and Germany. The price of lumber and fuel and the necessity of providing for the future have caused many to think of the question of reforesting denuded lands. The following deals with tree planting in relation to the farm and small land owner:

Choice of Species.—In forest planting we are limited to certain species of trees owing to various factors. Some of these factors are: (1) Hardiness and rate of growth, (2) nature of soil to be planted, (3) kind of wood crop desired, (4) availability and cost of planting material. One of our best guides in replanting will be found in the original natural distribution of trees. Through many generations certain species have become adapted to certain areas having certain conditions. Such distribution may be spoken of as geographical, and local. Geographical distribution depends on climatic factors, as temperature, amount of rainfall and atmospheric moisture. Local distribution depends on local variations, as quality of soil, drainage, exposure, etc.

Hardiness and Rate of Growth.—A species might be hardy and still its rate of growth and development be so slow as to preclude its use in practical planting. To illustrate this the Black Walnut is found throughout an area extending from the southern part of Ontario to the Gulf States and from the New England States to Kansas and Nebraska. Within this area the Black Walnut probably has its fastest rate of growth and development in the central region, as Indiana and Tennessee. In southern Ontario its growth and development is such that its use in replanting should be very limited. The fancy prices paid for Black Walnut have been for trees from 200 to 400 years old. The White Pine is distributed over an area extending from Manitoba to Newfoundland and from the height of land in northern Ontario to Tennessee and Georgia. The region of its best development is in the Lake States and Provinces. There is probably no better species for planting work in Ontario. Ontario is near the center of its range and in this Province it may be found thriving in all classes of soil from wet, heavy locations to light, sandy ridges.

Of our two common Oaks, the White and Red, it might be thought that the White would be the better to use in planting work, as it demands a better price in the market. However, it is probable that Red Oak will give the best returns for the following reasons: White Oak is a comparatively slow growing tree in Ontario, whereas Red Oak makes a good growth even in waste types of soil. In replanting we must consider species which will give best returns on waste land and not put too much faith on those which have brought fancy prices in the past. Frequently these high priced species grew on soil which to-day cannot be used for forest crops.

Nature of the soil.—The nature of the soil must influence the choice of species. No arbitrary division can be made, as the choice can only be decided with relation to local characteristics of the situation to be planted. However, some general divisions can be made which will aid the prospective planter. In nature we find White Elm and Arborvitæ, growing in dry situations on high land, but these same species have a better development in low, moist soils. Some light, shifting, sandy soils produced magnificent trees, but when cleared left the soil unprotected. Such soils may at first require species adapted to poorer sites, but after protection has been obtained more valuable species making higher demands on the soil may be used.

The soils of denuded lands are very deceptive in relation to tree growth. In many sections there are sandy ridges which in some localities are blowing and shifting badly. The sandy soil in these places would seem too dry for any kind of growth. However, upon going down a short depth we find plenty of moisture throughout the summer, and this dry looking soil is well suited for tree growth.

The following general classification may be made as a suggestion, based, so far as native species are concerned, on original and present distribution in Ontario. It must be noted in this classification that species are placed from the standpoint of endurance; that is, certain species will endure extremes of dry and wet, but would of course grow in the medium condition of fresh soil. In forest planting it is necessary to find species which will endure the extremes. Classification made in relation to moisture content of soil: *Very Wet Soil*—Arborvitæ, Tamarac, Black Ash. *Wet Soil*—Norway Spruce, White Spruce, White Pine, White Elm. Bur Oak, Red and White Maple, Tulip. *Fresh Soil*—White Oak, White Ash, Rock Elm, Black Cherry, Sugar Maple, Black Walnut, Chestnut. *Dry Soil*—Red Pine, Scotch Pine, European Larch, Red Oak, Chestnut, Black Locust. *Very Dry Soil*—Scotch Pine, Red Pine, European Larch.

Classification made in relation to tenacity by which we say a soil is stiff or loose, heavy clay soil and light shifting sand being the two extremes: *Heavy Clay Soil*—Norway Spruce, Arborvitæ, White Pine, White Elm, Rock Elm, Red and White Maple, Black Cherry, Black Locust. *Loose Sandy or Gravelly Soil*—Red Pine, Scotch Pine, European Larch, White Pine, Chestnut, Red Oak, Black Locust. *Very Dry Shifting Soil*—Scotch Pine, Black Locust.

Kind of Wood Crop Desired.—The choice of species may be influenced by the local markets. In a fruit district the demand for posts and stakes may be so important that it would be well to plant species which would furnish this demand. Fencing material is always in demand in an agricultural country so that Black Locust, Arborvitæ, Red Oak, and Chestnut should always be safe investments in planting.

Availability of Planting Material.—The prospective planter will be limited in his choice of species, by the availability and cost of planting material. Our native Red Pine is probably suited to sites similar to Scotch Pine, and it might even prove a better tree for replanting work. However, the price of Red Pine seed and the cost of nursery plants, place Red Pine out of our consideration at present. Scotch Pine seed is quoted by a German dealer at 85c. per pound, while an American dealer quotes Red Pine seed at seven dollars per pound, and is unable to fill orders. The following comparison of prices of planting stock may be of interest in this connection. These prices are for season of 1906-07, and are quotations per thousand at point of shipment, for plants fit for final planting. Better quotations may be had for 10,000 or 100,000 lots.

Species.	Size.	North America.	Europe.
Scotch Pine.......	6 in. to 10 in.	$ 6.00	$1.20
Norway Spruce...	10 in. to 12 in.	15.00	2.00
Larch	10 in. to 12 in.	20.00	2.90
White Pine.......	6 in. to 10 in.	16.00	3.00
Red Pine.........	No quotations.	.....	....

Size and Quality of Plant.—We have come to think of the operation of planting trees as very laborious and expensive. The average person in this country thinks that the operation consists in digging a large hole and placing in it a tree or sapling of from six feet to twelve feet in height. On the other hand, the forester uses a small plant from 6 inches to 18 inches high for the following reasons: The smaller plant does not cost as much as the larger. It is less expensive to place in position. Its chances of becoming established are better than in the case of the larger plant. In moving and planting the small seedling or transplant, the root sytsem of the plant does not become as greatly injured as is the case with the larger plant.

Nursery Grown vs. Native Planting Stock.—Nursery grown planting stock will in most cases be more advisable than that taken from the native woods. A seedling taken from the woods has had the protection of surrounding trees; it has a loose, ranging root system which must necessarily be considerably injured in lifting to transplant. In most cases it will cost more to collect plants growing scattered throughout the woods than it will to buy them from nurserymen. The nursery grown plant is specially treated to stand the handling necessary in making plantations. It is grown in the open without protection, and by transplanting has been made to develop a compact root system. The more compact the root system, the easier it is to place it in final position in the ground and properly cover the roots.

Time of Planting.—The transplanting or moving of a plant is an operation which seriously affects the constitution of the plant. It should be done at a time when it will least affect the growth of the plant. If the transplanting can be carried out without disturbing the soil about the roots of the plant and without subjecting the plant in its new surroundings to new conditions, the operation might be performed almost any month of the year. As this is impossible in forestry where the operations are usually on a large scale, we must do the work during a season when the plant is in a resting stage. For climate and conditions like Ontario the early spring seems to be the most suitable. The planting of evergreens is being successfully carried on between the middle of August and the middle of September.

Handling of Planting Material.—In cases where the prospective planter receives his planting material from a distance by freight or express it should not be left lying at the office or sheds any longer than possible. No matter how well the material may have been packed there is danger of overheating, moulding, or excessive drying taking place in the express office or shed owing to lack of air. The treatment upon taking the stock from the express office depends upon local conditions. Where possible, it is best to unpack the plants in the shade. They should never be subjected to the direct rays of the sun. Where the planting cannot be done at once, it will be advisable to unpack the plants and heel them in, in some place protected from the sun. Heeling in is simply covering the roots of the plants with soil. The plants are usually shipped in bundles of from 25 to 50 or 100, and if bundles have been packed tightly it may be advisable to break them open and loosen them up before heeling in. Where possible, the trees should be heeled in near or on the place of planting, and if there is a stream of water near the planting ground it would be well to heel in close by this.

When the work is to be done at once, the quantity of planting stock small and the plants have not been lying in transit very long, it may not be necessary to heel in.

Density of Planting.—In making plantations, it is necessary to plant closely enough so that the ground may be well shaded to prevent the growth of grass and weeds. Close planting also protects the ground and forms the needed humus in a shorter time. The closeness of planting depends also on the species and the desired wood crop. If trees with clean, tall stems are desired, it will be necessary to plant closely enough so that natural pruning will take place; that is, as was pointed out in previous pages, the lower side branches will die from shading and the height growth of the tree will be rapid during the early years of its life. Some species, as Oak and Walnut, do not form a perfect ground cover, and mixtures must be made to obtain this condition. Much difference of opinion exists as to the proper spacing of plants in planting work. The number of plants and the spacing need not be fixed, but may vary with local conditions. For most species the spacing should not be over six feet. Number of plants required to plant an acre of land in squares:

3 feet 0 inches between the rows	4,840 plants.
3 feet 6 inches between the rows	3,556 plants.
4 feet 0 inches between the rows	2,722 plants.
4 feet 6 inches between the rows	2,151 plants.
5 feet 0 inches between the rows	1,742 plants.
5 feet 6 inches between the rows	1,440 plants.
6 feet 0 inches between the rows	1,210 plants.

The area may be planted in regular lines if roughness of the site does not prevent it, but if land is broken by stumps, rocks, etc., it may be necessary to distribute the plants wherever possible. The more regular the planting is done the easier it will be to find and protect the plant against being overtopped by weeds, etc. Also dead plants may be easily located and replaced. It will be easier to properly distribute the planting material over the area where regular lines are followed.

Different classes of soils present varied problems in planting work. Cultivated soil which is usually good agricultural land; light gravelly or sandy soils which cannot be cultivated for fear of blowing, washing out, etc., and rough rocky or steep land which it would be impossible to cultivate, need certain differing treatment.

The ease and speed with which planting may be done depends upon the looseness of the soil. Where soil has been cultivated the operation is a simple one and can be done with a common spade. The planting hole can be made by driving in the spade and moving it backward and forward, giving an opening. If the soil is very sandy and loose, the plant may need to be placed in position before the spade is removed to prevent the filling up of the planting hole. In some cases the soil may be worked about the roots with a planting peg, which can be made in a few minutes. Frequently the planter discards the above tools and prefers to place the soil about the roots with his hands, which method is probably as satisfactory as any. After the roots have been covered it is very necessary to firm the soil, which may best be done with the foot. The roots should always be firmly covered.

The plants should be transferred from the spot where they are "heeled in" or packed to the planting hole by carrying in a pail. This pail should contain muddy water the consistency of a batter and the plants should have their roots submerged in this batter. Plants should be immediately transferred from pail to planting hole and covered at once. The roots of the plants should not be allowed to have the direct rays of the sun for a moment. In no case should the plants be dropped in advance of the planter, as it gives the soil an opportunity to dry out. A man and boy can do this work very well together, and two working together will obtain the best results. One preparing the planting holes, the other placing the plant and covering it.

In light sandy soils which have a thin turf or covering of grass and weeds, it is advisable to strike out *very shallow* furrows with the plow. These furrows should be shallow, so that the plant will not lose the advantage of any humus which may be in the surface soil. The furrows will act as planting lines and will also aid in future inspection. The overturned sod will give the plant protection from grass and weeds if the plants are placed near the side. The soil in this furrow will also have a better moisture content than surrounding surface soil. In many cases the plant is better protected from winds.

The plow can also be used in hillside planting where it is possible to put horses. By running furrows for planting lines along the side of the hill a ledge is left, which will aid in the operation. In planting on this ledge the plant should be placed near the outside, so that it will have the surface soil which contains most humus. This furrow has advantages similar to the case cited above. In cases of running furrows of this nature on a hillside, the plowing should commence on the highest point, so that rolling turf will not interfere with operations. Never run a furrow with the slope up and down the hill, as washing might occur.

If it is desired to plant in rough conditions where the running of furrows is impractical, other methods may be followed. Where there exists a dense turf in stony soils the mattock or grub hoes may be of great service. The sod can be cut off with the grub hoe or mattock and the soil loosened with a pick, or in case of using the mattock by using the pick like part of the mattock. In very rough planting one man can handle the mattock and prepare the planting spot, another prepare the planting hole with the spade, and a third do the planting. However, no definite rules can be laid down, and the arrangement must be settled for the individual case. In some lands it might take two men with mattocks to prepare ground for one planter. In all rough planting of this nature it is advisable to follow as definite lines as possible so that future inspection may be possible as well as insuring a proper stocking of the area. Good soil will usually send up a dense growth of weeds that would in many cases choke out young plants. Such soil where possible should be fallowed before planting and cultivation carried on for at least two years after planting, which would give the young trees a splendid start.

In some cases soil which produces rank weed growth will be located so that it will be impossible to cultivate. In such locations it will be necessary to go through the plantation, once or twice during the summer, with a scythe and free any plants which are being overtopped by weeds. Only the most reliable workmen can be depended upon to do this, as careless workmen will invariably cut off or cut back young plants.

In planting on this kind of soil, it is important to plant in somewhat regular lines so that the plants may be located easily. It is also necessary to use strong, well developed transplants. After first or second season the plants will get above the danger line of weeds. In many waste types of land the grass and weeds are so sparse that they do not endanger the young plant. Frequently in such cases the growth of weeds or grass make a good protection, especially in the winter.

In some of the sandy soils it is necessary to protect the plants in the most exposed situations from the drifting sand. The danger may be that the plants will be covered with drifting sand or that the sand may blow away and leave the roots exposed. This may frequently be averted by scattering brush or other debris between the planting rows in the threatened areas. The best results on the above areas will be obtained by planting evergreens so that protection may be had both summer and winter. For the most exposed locations, Scotch Pine and Jack Pine will be the most advisable trees to plant.

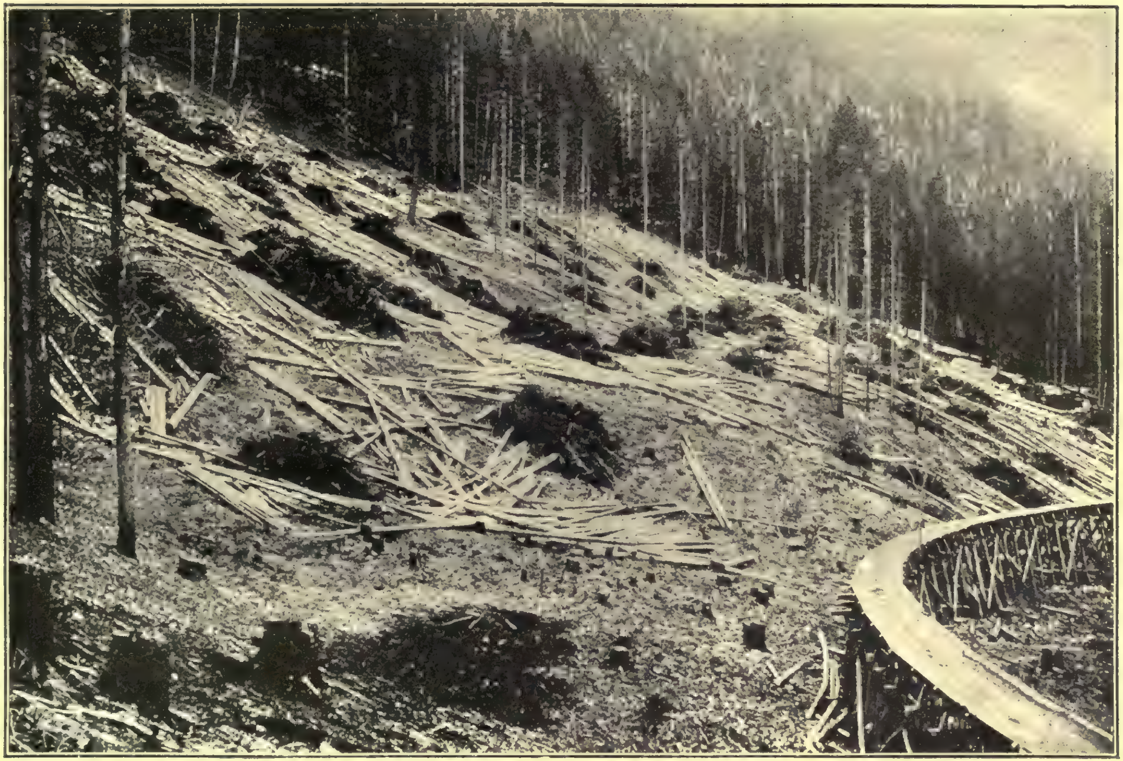
The more protected spots in a planting area might be filled with White Pine, Red Oak, Black Locust.

Planting of Nuts.—Species which have seeds and seedlings subject to many dangers if sown in rough, wild places should be reproduced by using the nursery plant. Many of the nut tree species, however, can best be propagated by planting the nuts in final position rather than by using nursery stock. Nut tree seedlings are generally quite hardy after germination, making it quite safe to plant them in rough places. The common nut trees are White Oak, Bur Oak, Red Oak, Black Oak, Beech, Chestnut, Bitternut Hickory, Shagbark Hickory, Butternut, and Black Walnut. Of the above species, Red Oak and Chestnut give promise of being the most useful and practical in waste lands, especially where the soil is light and sandy. Red Oak, White Oak, Chestnut, Shagbark Hickory, and Black Walnut are found naturally in loamy soils. Bur Oak and Bitternut Hickory are found in the heavier classes of soils.

The collecting of nut seeds need not be described, as everyone has had some experience. Care should be had not to gather such nuts as Black Walnuts too green. The safest time to collect is after the nuts have naturally fallen to the ground. White Oak acorns frequently germinate in the autumn shortly after falling. Acorns which have started to germinate will need careful treatment in handling. If the acorns are collected upon falling to the ground and placed in a cool, dry place, there will be little danger of autumn germination.

Nuts may be planted in the autumn or stored and planted in the spring. Autumn planting has some drawbacks. The edible nuts are frequently found by squirrels or other rodents before they have germinated. In wet soils and cold, damp seasons the nuts may lose their germinating power from decay. The care and storage of nuts needs some attention. The nut may have the husk taken off, although there is less danger of drying out if it is not removed. Drying out is the greatest danger to be feared after nuts have been collected. In no case should they be placed in artificially heated rooms. After collection the nuts should be spread out in some dry, cool place for a few days until they are well matured. Care should be taken both in storing and maturing not to leave nuts piled so deep that they might heat. While maturing they should be turned over occasionally.

Seed may be stored by putting them on a well drained spot and covering them with leaves or hay over which may be placed a light covering of brush. Storing in a pit is a safe method. Layers of nuts six to ten inches deep covered with leaves or small twigs and topped off with soil three to four inches in depth provides good storage. A light covering of brush or hay over the pit will prevent washing of the top dressing of soil. A ditch at the side will give drainage. The bottom of the ditch should be well below the general level. Nuts can also be safely stored by stratifying them in sand. Stratifying seed is done by making a layer of sand and then a layer of seed mixed with sand. This may be done in a well drained trench or in a box. In the case of storing in a box the box should be covered



Strip Method of Cutting in National Forests.

lightly with soil. If left standing unprotected it will dry out and injure the seed.

The preparation of the planting area will be similar to that described in previous pages. Where planting is to be done in sod it will be necessary to cut away a square of sod. Planting the nut is very simple and may be done with a sharp-pointed stick or dibble. With this instrument a hole is made in the planting spot and the nut dropped in. In loose soils the nut can be sufficiently covered by a stamp of the heel. When the soil is heavy it may be necessary to cover the nut by prodding with the dibble. The nut should be planted deeper in loose than in heavy soils. The depth should be from two to three inches, depending upon the looseness of the soil.

Planting Along Permanent Fences.—The question of securing fence posts at a reasonable rate and their short life after being placed in the ground is a problem confronting the agriculturist. One solution of the problem may be found in planting trees along permanent fences. In a short time it will be possible to attach the wires to these trees.

The trees can be planted every sixteen feet or even every eight feet as the owner desires. Strong, vigorous plants should be chosen for such work and in the case of using evergreens, transplants should be used as the fence lines are frequently filled with dense grass and weeds which will endanger the young plant. More attention can be given the making of planting holes and the actual planting than in the case of waste land planting. Where a rail fence now exists and there is no chance to cultivate, the planting hole should be made by cutting away a large sod about two feet square. Occasionally it may be practical to cultivate a strip four to six feet wide along a fence which can be moved a few feet after the trees have grown. Preparation of this strip by summer fallowing will give results in future tree growth which will repay the effort. Whether planting is done in planting holes or on a prepared strip, future cultivation will give best results. This cultivation should be carried on for two years at least—longer will pay—until the trees have become well established. It will be an advantage to mulch the trees with grass or old manure. The trees should be inspected during the summer to see that weeds, etc., do not overshadow them. In case the owner does not want large trees along cultivated fields, the first planting can be done every sixteen feet and a few years later trees can be planted between. When the first trees become too large they can be cut off the height of a common fence post and later the fence can be attached to the younger generation of trees as the older ones decay.

This choice of species for this work must be given some consideration. The fastest growing species will be Box Elder, Hardy Catalpa, and Black Locust. In the best classes of fresh, moist soils Hardy Catalpa may prove valuable for this purpose. Black Locust will grow on the poorest of locations and will be of more general value than Hardy Catalpa. Sugar Maple may be employed in this work, although the growth will be slower than the preceding species and it requires very good soil. Some may desire to plant nut producing trees so that a return may be had from nut crop. Black Walnut, Shagbark Hickory, and Chestnut would be the most valuable in this case. The Chestnut would grow on the lighter soils, while the Black Walnut should be planted in good, rich soil. If evergreens are desired, Norway Spruce, White Spruce, Larch, and Arborvitæ will give best results. The Arborvitæ should be placed in moist soil, while Larch will stand dry, poor locations. In placing wire on trees, care should be taken not to injure the tree more than necessary. Where the strip of wood is used in which to place staples, the tree gradually forces the strip over the head of the nail and in time it may be necessary to put in new nails. As a rule, large bolts or heavy spikes are used to fasten this strip to the tree. The use of such large fastenings is unnecessary and usually a much smaller nail will hold just as well. For an inch and a half strip two and a half inch nails are sufficiently large.—(Ont. A. C. B. 155.)

FOREST TREE PLANTING ON THE PRAIRIES.

On the unsettled prairies there were no barriers to obstruct the constant winds. Tree planting was early recognized as the best means of accomplishing this. In order to encourage tree planting generally, Congress passed the timber culture act of March 3, 1873. Under this law and its later modifications a good deal of planting was done, both to meet the requirements of the act and to secure the benefit of protection.

In the matter of growing trees some had better success than others. Europeans often used to good advantage the experiences they had got abroad. A number of species were introduced; but generally the native trees furnished the most readily available planting material. Cottonwood, boxelder, silver maple, green ash, and white elm are the species that have been most generally tried. Partial successes are rather more common than complete successes. Failures may be attributed in some cases to insufficient preparation of the soil, to wide spacing of the trees, infrequent cultivation, to insects, fire, animals, etc., but mostly to the occasional droughts already referred to. Failures of conifers result from the planting in too small quantity, from the use of too large plants, and from the drying of the roots before planting. Yet, notwithstanding failures, there are many good groves.

In the native trees the discussions of the merits of the species are based upon the general conditions of the region and upon actual measurements of a number of typical planted groves. In the case of introduced trees the data are derived from measurements of groves and from literature on the requirements of these trees. Adaptability and economic usefulness have been the leading considerations in recommending a species for future planting.

DOES IT PAY TO PLANT TREES?

Up to the present time groves have seldom been established for direct profit. Owners, however, estimate the value of their groves, on an average, at $1,000 an acre, on the basis that their property would be enhanced to that extent if placed on the market. In the purchase and sale of land the grove is really one of the foremost considerations. No one knows the location and character of groves better than the land agent or the president of the county bank. People pay for the benefit of protection and comfort as they pay for such benefits in a city.

Planting for Protection to Farmsteads.—In this region protection is required on the south, west, and north sides of buildings. The number and kinds of trees planted largely determine the effectiveness of the windbreak. While many of the protective plantations comprise less than ten acres, this area is not greater than efficiency demands. At the same time the plantation may produce fuel and other material for farm uses. Since the cold winds are from the north and west, the larger part of the plantation should lie in those directions, and should consist of hardy, rapid-growing evergreens. These afford the best kind of protection when most needed. Deciduous trees are best for the southern part of the plantation. Gaps in the windbreak may seriously affect its protective value, and should always be avoided.

Planting for Commercial Purposes.—A certain amount of planting may be done for protective and woodlot purposes without regard to its profitableness. When, however, planting for direct profit is contemplated, more extensive inquiries become necessary. No one would plant trees for profit without a reasonable assurance of realizing it. Whether it pays to raise a wood-crop depends upon (1) the market, (2) the cost of producing it, and (3) the species planted.

As a result of the absence of natural supplies, posts, poles, and fuel-wood are shipped into this region from northern Minnesota at a freight rate of 10 cents a hundredweight, or about $3.50 a cord. This, with the original selling price and the dealer's profit, brings the local selling price up to from $7 to $11 a cord, depending upon the quality, which is often inferior. In some instances wood is sold by weight. Even at these prices woodland owners do not seek the prairie trade. Cement and iron fence posts have been offered as substitutes for wooden posts, but as yet unsuccessfully. The chances are that all classes of posts, lumber, and fuel will continually increase in price.

The value of the land is the first and, in some cases, the largest item in the cost of producing a wood crop. Although trees can be grown with profit upon the best soil, they do not require it. Wherever there is soil too rough, too hilly, too sandy, or too wet for agricultural crops, it should still produce good crops of trees, and for that purpose should be the first selected. In case willow and cottonwood are used the cost of the planting material should be trifling. Cuttings may often be had for the trouble of gathering them. Unfortunately, coniferous stock is expensive. Planting and cultivating are some of the smaller items of expense.

In selecting a tree for commercial planting, its adaptability to the climate and situation, and rapidity of growth are the chief considerations. A tree may be perfectly hardy against cold, like willow and cottonwood, but may not be drought resistant. Hence it must be planted on sites that afford sufficient moisture for its best growth.

Another tree may be drought resistant, but may grow too slowly upon dry ground to make it profitable. The time element is always a foremost consideration. If a tree crop is an investment then the sooner it matures the better. The different trees native to this region have usually been divided into two classes: The rapid-growing softwood species, and the more slowly growing hardwood species. The former flourish only in the moist, porous soils of the river valleys, and under such conditions produce a large amount of material in a short time. While the market recognizes a slight difference in price between the two classes of woods, this difference does not seem to equal the difference in the amount of production. Thus an acre of cottonwood might produce 3.5 cords a year, while one of ash would produce 1.5. At $3 a cord the first acre would bring $10.50; at $5 a cord the other would bring $7.50, or a difference of $3 in favor of the fast-growing cottonwood. Quantity rather than high quality is the present demand. Fuel wood need not be durable. The life of non-durable wood can often be lengthened by proper preservative treatment, or by using it in places where the conditions are unfavorable for decay.

Trees Recommended.—Measurements show that the native species studied do not grow fast enough upon the upland to justify their planting for profit alone; yet two introduced species, European larch and Scotch pine, produce respectively an annual net return per acre of $11.93 and $13.35 and can be planted as a commercial venture. They are both hardy and profitable upon upland and would show even better results when planted in the river valley. The pine can be grown in pure stand, but both can be grown to better advantage when mixed with white spruce.

CONIFERS.

Their Commercial Value.—Of the many trees occurring naturally in a country only a limited number can be considered economic species. To have economic significance a tree must be both useful and profitable. Broadleaf species, as a class, are hard and heavy, and often so scattered that their exploitation is difficult and expensive. On the other hand, conifers generally occur in pure stand over large areas, and are thus cheaply converted into lumber. At the same time they possess a combination of qualities that give them preference with the user of wood. The economic significance of the conifers is reflected in the lumber industry of the united States, 80 per cent of all the sawed timber being derived from this class of trees.

Referring to Prussia, a country in which systematic forestry has been carried on for a long time, and where forest finance has been highly developed in conformity with general economic conditions, an authority states that, in consequence of the economic management of forests, among the numerous indigenous species which formerly existed, only those have been preserved which possess a high value; that 67.5 per cent of the forested area of the country consists of conifers, and that the broadleaf species—oak and beech—are declining in use, while the conifers are increasing. (Scotch pine alone covers a larger area than all the broadleaf species together.)

Their Protective Value.—To be of commercial value a species must possess adaptability, usefulness, and rapidity of growth. These should have foremost consideration even when planting is done mainly for protection, as in the region embraced by this report. Here protective planting is so absolutely essential that groves of deciduous species of little commercial value, which afford shelter only during summer, have been valued at $1,000 an acre. Surely, then, conifers, which are more valuable commercially, and which afford protection during winter when there is most need for it, should be worth a slightly higher price and the extra care necessary in securing a satisfactory stand.

Conifers are sometimes objected to on account of a possible yellowing of the leaves. This is reported as occurring during hard, open winters, with occasional warm, sunny days. On the warm days the leaves become active and transpire water at a time when the frost-bound soil can not supply the loss, hence the drying or "yellowing." This trouble is experienced mostly with trees that have no protection whatever against the sudden changes of heat and cold. Deep-rooted trees like Scotch and western yellow pine, etc., should be planted in preference to shallow-rooted kinds. They should be planted in dense stands, so that they can prevent deep freezing of the soil and protect each other from midwinter stimulation.

So far the main objection to the general planting of conifers has been the excessive cost of the planting material. Experience, however, has proved that coniferous stock can be grown in quantity at a cost which does not make *its use prohibitive.*—(F. S. Cir. 145.)

Trees and Methods Recommended.—Forest trees for windbreaks should be planted in belts varying from 2 to 8 rods in width, except along fence lines, where they are in single rows. The best results, purely from the standpoint of forestry, will be obtained in the widest belts, since trees are social in their habits. Still better tree growth would be secured by planting in compact blocks. But as agriculture is the fundamental industry in the region to which this plan applies, the tree planting is designed only to supplement the production of field crops. Eleven or 12 per cent of each quarter section is to be devoted to forest. This is exclusive of the space occupied by the single lines of trees in the fence rows.

The species that may be recommended for this purpose vary for each particular locality with conditions of climate, rainfall, and soil. Considering the Middle Western States together, however, the following trees, when placed on hospitable soil fulfilling the requirements of each individual species, may, in the northern half of the region, be successfully grown as windbreaks: Arborvitæ, green ash, boxelder, cottonwood, cork elm, white elm, European larch, Russian wild olive, western yellow pine, Black Hills spruce, laurel-leafed willow, Russian golden willow, and white willow.

In the southern half of the Middle West, also the green ash, cottonwood, white elm, Russian wild olive, and western yellow pine may be successfully grown, and in addition the following species: Chinese arborvitæ, wild China, black locust, honey locust, mesquite, Russian mulberry, osage orange, persimmon, and shittimwood. These lists do not include all of the best timber trees that might be grown in the Middle West, for many valuable timber trees will not endure such severe exposure as a windbreak is subject to.

In the establishment of a windbreak wisdom is required in the placing of the different species. A windbreak composed of more than one species is usually the most effective. An excellent method of arrangement is to place the shortest trees in the outside row (toward the prevailing wind), to plant a somewhat taller species next to them, and to place the tallest trees in a third row on the side adjacent to the buildings or the area which is to be protected. This causes the wind to strike the trees as it would strike the face of a steep hill, deflecting its course upward. If the tallest trees of the third row consist of a flexible species, such as cottonwood, European larch, white willow, or honey locust, they will bend before the wind, and act as a cushion to deflect it upward and over the object to be protected. A satisfactory windbreak 5 rods in width, for the protection of the north and west sides of a farmstead and adapted to Minnesota and the Dakotas, is as follows: Plant 13 rows of trees, parallel to one another and 6 feet 10 inches apart. The first two rows on the north and west edges of the belts should consist of Russian wild olive, the third and fourth rows of arborvitæ, the fifth and sixth rows of box-elder, the seventh and eighth rows of white elm, the ninth and tenth rows of white willow, and the remaining three rows of common cottonwood. Such a plantation, when mature, will appear like a wall with a sloping top, the highest side being where the cottonwoods are planted.

Carrying out this same principle for Oklahoma and Texas, with a change in the position of the plantations to afford protection from southwest winds, the following method is advised: The first two rows on the south and west edges of the belts should consist of Russian mulberry or Osage orange, the third and fourth rows of Chinese arborvitæ, the fifth and sixth rows of black locust, the seventh and eighth rows of green ash, the ninth and tenth rows of white elm, and the remaining three rows of honey locust or common cottonwood.

In southern California, where the damaging winds come from opposite points of the compass (from both the southwest and northeast), a good plan for a windbreak is one in which the tallest, most flexible trees will be in the center rows, so that the species on either side will slope downward toward the outside edges of the belt. For such a windbreak 2½ rods wide and consisting of 7 rows of trees, the following arrangement may be suggested: Eucalyptus of the species best adapted to the site should form the three rows in the middle of the belt, the next row toward the outside on each side should be of Monterey pine (*Pinus radiata*), and the two rows occupying the two edges of the belt should be Monterey cypress (*Cupressus macrocarpa.*) This same arrangement may be used on a belt 5 rods wide by doubling the number of rows of pine and cypress and increasing the gum to five rows. In order to construct a windbreak in California that will be perfectly effective, the belts should be placed on all four sides of the area which is to be protected.

The belts advised in the model plan are of sufficient width to produce all the timber that will be needed on a farm of 160 acres, while the fields are sufficiently narrow to be protected from winds by the single lines of trees occupying the fence rows. Experiments have demonstrated that a windbreak, on level land, will be effective for a distance of at least ten times its height. For perfect protection on the model farms herein described, the trees in the windbreak must reach a height of at least 50 feet.

An objection to growing trees along fence lines has been made by farmers on the ground that such trees steal the soil nourishment from the crops which are on the edges of the fields. It is true that healthy, vigorous trees make great demands on the soil moisture in their immediate vicinity, but wherever their influence is felt as windbreaks they conserve enough moisture, by preventing rapid evaporation, to more than pay for all that they use. By planting a deep-rooted crop like alfalfa under the shade of the fence-line trees, good returns from the land may be secured in spite of the fact that the trees absorb a part of its moisture. It is a great mistake to begrudge a useful tree the space it occupies, and particularly so in the naturally treeeless prairies of the Middle West.

Special Features of Forest Planting About the Farmstead.—On rare occasions it is found to be impracticable to concentrate the different elements of the farmstead in one place. In the great majority of cases, however, it is both practicable and economical to have a farmstead, and the choice of its site is of the first importance to the landowner. If the farmsteads of several adjoining sections were laid out in accordance with the plan herein suggested, four farmhouses would be grouped at each crossroads corner, bringing neighbors together in a little settlement. The position at the crossroads is also likely to facilitate the reaching of church, school, and town. An argument against such an arrangement is the possibility of its leading to neighborhood quarrels.

In many cases, however, uniformity of soil does not exist. The farmstead must then be located with reference to the adaptability of the soil to the forest growth, since a farmstead without trees for shade and shelter is not worthy of the name. The forest planter, therefore, is often the one to determine the location of a permanent site for the farmhouse, and he may also lay out at least the plan of the farmstead itself.

Windbreak belts in connection with a farmstead form an asset that is none the less real because the actual money value may not easily be determined. The protection to an orchard afforded by forest trees is valuable, since late frosts are not likely to blight the fruit blossoms of a protected orchard. Forest belts on the south and west sides of the farmstead give ample protection against the parching blasts from the southwest—the hot winds of summer, which are destructive to fruit in many parts of the country. It is to be understood, however, that the forest plantations herein recommended are also to be utilized for the production of the needed timber supplies on the farm. By judiciously thinning the plantations, 20 acres of planted forest will furnish all the fuel needed on a farm of 160 acres, besides producing lumber for the renewal of the farm buildings. Many Kansas and Nebraska farmers have in twenty years grown cottonwood trees large enough for sawlogs. Mr. W. D. Rippey, of Severance, Kans., cut 200,000 feet of cottonwood lumber a few years ago from trees of his own planting. Mr. Rippey's plantations were on uplands where the soil is not particularly well adapted to the growth of cottonwood, and, when lumbered, were but little more than a quarter of a century old.

On the farm of Mr. T. F. Eastgate, near Larimore, N. Dak., in the Red River Valley, a belt of planted cottonwood trees, supplemented by a dense undergrowth of wild plum bushes, acts as a windbreak and snow catcher, causing a snowdrift to form in winter over the open field, which is devoted to alfalfa. In the summer of 1904 Mr. Eastgate harvested alfalfa hay from this field at the rate of more than 5 tons per acre.

Besides serving as a windbreak and snow catcher, thus making the growth of alfalfa possible on this farm, the forest plantation has produced cordwood during its twenty-one years of life at the rate of 4.74 cords per acre per annum.

The successful growth of alfalfa on 10 per cent of the area of this region would double the earning power of every acre of land in the Red River Valley; and, since the thermometer here sometimes falls as low as 50° below zero, it is possible to grow this extremely valuable forage only by utilizing some contrivance like Mr. Eastgate's windbreak, to catch the snowdrifts and form during the winter a protecting blanket over the plants.—(F. B. 228.)

General Cultural Notes.—With the exception of the sand hills, general suggestions may be made which will be applicable to the cultivation of forest trees throughout the plains.

In the preparation of the soil too much importance can not be attached to depth of plowing. The Western prairies, through long exposure to the action of the elements and to the tramping of the countless herds of buffaloes, which for centuries found in them a favorite pasture ground, have become far more compact than the forest-protected soils of the East. After a prolonged drought, such as frequently occurs, the autumn rains are not readily absorbed by the hard soil, and much moisture that might be saved to crops runs off and is lost to the fields. This is particularly true of the western parts of Nebraska and Kansas, and eastern Colorado. The same lands under deep tillage act very differently. Not only is the absorbing power of the soil increased by deep plowing, but the ability of such soil to retain moisture, under proper culture, is marked.

Land should be gradually prepared for tree planting by increasing the depth of plowing during three successive years, if so much time can be given to the work. The usual practice in the West is to break the land in June or July, turning as thin a sod as possible, and laying it flat, for which purpose the breaking plows are well adapted. Sometimes, on early breaking, a crop of sod corn or flax is grown the same year. After one crop is removed, the land is backset, when an inch additional is turned. For tree planting the depth should be increased from 2 to 3 inches at a time, until at the end of the third year the land may be plowed 10 to 12 inches deep. The advantage of this gradual preparation is in the complete subjection of the native growth of grasses and other herbaceous plants. This is a most important point in the economic growing of trees on the plains. If the native growth is entirely subdued, so that no live grass roots are present in the soil when the trees are planted, a great deal of after-labor is obviated.

One of the most obvious difficulties in the way of successfully meeting the requirements of the timber-claim law, which resulted, in spite of its defects, in so much good to the Western States, was the short time allowed between breaking the prairie sod and planting the trees. It was almost impossible under the methods of farming in vogue in the West to kill out the native vegetation in two seasons, but by gradually increasing the depth of plowing and by planting hoed crops the season preceding the setting of trees, the land can be completely subdued. Deep-plowed land will absorb much more of the melting snows and the spring rains than shallow-plowed land with the compact underclay within a few inches of the surface. By the time the planting season opens, in a year of ordinary rainfall, a deep-plowed field will be in excellent condition to receive the trees so far as moisture is concerned.

Thorough pulverizing of the soil is but little less essential, as a preparation for trees, than deep plowing. The particles of the soil should be fine in order that they may be brought in close contact with the roots of the trees, and thus supply them with moisture. If the field is rough and full of clods, the land will dry out rapidly. The thorough use of the disk harrow, clod crusher, pulverizer, and smoothing harrow is quite as important in preparing land for trees as in the preparation of a field for a crop of wheat. Not only will trees start more quickly when set in well-prepared soil, but the growth will be more uniform and strong.

As in all other hoed or cultivated crops, it is important to keep the surface of the soil in fine tilth until the trees have grown sufficiently to shade the ground. Deep plowing and shallow cultivation should be the rule in all kinds of Western farming. The deep plowing gives a large absorptive area, and shallow cultivation places over the moist soil a dust blanket that acts as a most effective mulch, checking evaporation and thus retaining the soil-moisture for the use of the trees. The Western planter must keep constantly in mind the necessity of saving, by every possible means, the moisture of the soil. In the Eastern States, which have a well-distributed rainfall of from 30 to 50 inches, this is a point of comparatively little consequence; but beyond the Mississippi its importance increases as one goes westward.

Planting trees.—In planting trees careful alignment will save much labor in cultivation. It will pay to mark the land as carefully as for corn where groves of 10 acres or less are to be set, and to begin planting all the rows from the same side of the field, as the slight deviation resulting from pressing the spade forward in planting will thus bring all the trees in even crossrows. Almost all seedling forest trees can be set with a broad dibble or spade, which is sunk blade deep at the cross mark, the soil pressed forward, the roots so inserted as to avoid turning the tip upward, and the soil pressed firmly about the collar with the feet, brushing a little loose dirt over the pressed places to prevent baking. When planting in this way, the seedlings can be carried in a pail with a little water or moist earth. In mixed planting it will be found most convenient to set all the trees of the prevailing species first, leaving the places for the kinds that are to be used in smaller quantity to be planted afterwards. Where two or three shade makers are used the same method can be followed, or each kind may be handled by a different planter, all working together.

It is also desirable to take all the trees to the plat to be planted and heel them in where they can be easily reached. Special care should be taken to prevent the drying of the roots of conifers. Where the roots are large and fibrous, it will be found best to dig a hole for the trees, setting them in the same manner that orchard trees are planted. Care should be taken to secure perfect alignment in this method, as when the rows are irregular it is impossible to bring the cultivator close to the trees.

Exposure of roots.—It occasionally happens in the West that during the early summer, or after the leaves have dropped in the fall, the surface soil will be blown away by the hard winds, exposing the roots to the drying atmosphere. To prevent this, the trees should be set an inch deeper than they grew in the nursery, and in autumn, after the leaves have fallen, a shallow furrow should be turned to the trees, so as to throw the dirt against the trunk. This can be done with the shovel attachments of the ordinary wheel hoe, which is one of the most useful implements that can be used in the young tree plantation.

Cultivation.—The amount of cultivation beneficial to young trees can not be determined by freedom from weeds, nor by the number of times the operation is performed. In seasons of prolonged drought frequent stirring of the surface soil will be found of great benefit, as it will keep over the surface a layer of loose, fine earth, which will quite effectively check evaporation from the moist soil below. After rains the stirring of the surface soil will prevent the formation of a crust which indicates the too rapid loss of water from the soil. Weeds and grass should be kept out of the trees, because they use the moisture that will be needed for tree growth. Ordinary shallow cultivation will be found sufficient for annual weeds—including the Russian thistle, sunflower, and mustard—if begun early and continued regularly, but the only way to get rid of the couch grass (*Agropyrum repens*) is to carefully dig out its underground stems and remove them. It is well to be on the watch for this pest, for when once established among trees it is almost impossible to eradicate it.

Cultivation should cease at midsummer, in order not to encourage too late growth and consequent danger of winterkilling. Thereafter large weeds can be cut out with a hoe, or a thin crop of oats or buckwheat can be sown among the trees to hold the soil during the drying winds of late summer and early autumn. After the leaves fall, a shallow furrow turned against the trees will prevent exposure of the roots by the late fall and early spring winds.

The best implement for cultivating young trees is a harrow-tooth cultivator. The horse hoe, with its varied attachments, is useful in the tree plantation, as well as in the fruit and vegetable garden. During the first year a two-horse cultivator can be used, but it should always work shallow; the result, however, is not so satisfactory as with the finer-toothed machine.

Two or three years, depending on distance and upon the season, should be sufficient for the cultivation of any carefully designed mixture of forest trees. At the beginning of the second season all blanks should be reset, and again the third spring. This should insure a full stand of trees. Thereafter the knife and pruning shears must take the place of the cultivator.

In river and creek valleys, where water is found at from 5 to 20 feet below the surface, cultivation is not ordinarily necessary after the trees are thoroughly established. The same is true in many places on the upland, where shallow depressions catch the run-off from considerable adjoining areas. In such situations the supply of water may be concentrated on any desired part of the depression by running furrows to it from the surrounding slopes. This method has been successfully used by some of the most progressive western farmers.

Pruning a Young Plantation.—In a properly designed plantation of forest trees very little pruning is necessary, though the temptation to use the knife is often great. If in passing through the plat a tree of upright habit is found to be forked near the ground, or to be forming two leaders, one of the branches should be cut away. If the shade-enduring trees are found to be overtopping the light-demanding kinds, the former must be headed in. This rule, however, must be used with judgment. It will often happen, as with the oaks, that the more valuable species is seemingly harmed by its neighbors, when in reality it is making strong root growth, and is none the worse for the temporary overtopping.

Many trees, like the black wild cherry, form a mass of fine branches while young and look as though they would never make a leader and grow to a single trunk. These should be permitted to grow without pruning in thick-set plantations. As soon as their neighbors begin to crowd them one of the many branches will take the lead, and the plant will assume tree form, the many lateral branches dying off as the stem grows upward.

It is no advantage to "trim up" young trees by the removal of their lower branches when they reach a height of from 12 to 20 feet, especially in mixed plantations and on the prairies. The very purpose of close mixed planting is to force the trees to prune themselves, and they can be depended upon to do this as it becomes necessary. The lower branches aid very much in making the plantation effective as a wind-break. While small and weak, in the aggregate they make a strong barrier to the wind, and should be left for this purpose, if for no other. A possible exception may be named in the catalpa; but even in this tree the lateral branches should only be removed as they show signs of dying, and then only because, being persistent and not shed after a year or so, as with most deciduous trees, they make defects in the timber of the trunk.

Thinning.—Thinning trees planted 3 by 3 feet is seldom if ever necessary until from five to seven years after planting; and at the first thinning the removal of comparatively few trees will be advisable. It may be best to head in some of these trees by clipping their lateral branches in the intervals between thinning, but our strong Western soils should be able to carry the full stand until from five to ten years old, and the subsequent thinnings should be at intervals of from seven to ten years.

Grazing—Fire.—Grazing animals should be rigorously excluded from all tree plantations. Even if the trees are too large to be broken off by the stock, every branch within reach will be browsed, and the desirable forest conditions of shade, undergrowth, and litter will be destroyed. In a well-established grove stock may do little harm, but until the crowns of the trees are entirely out of reach cattle should not be admitted. Even then injury may result from the trampling of the soil. A heavy soil becomes packed so that it is nearly impervious to water, while a sandy one is worn and blown away, leaving the roots exposed. The damage to large trees in situations where moisture is abundant is not usually great, and the protection furnished to stock in such a case may more than offset the slight injury to the trees. Every tree plantation needs to be protected by some form of fire guard. Where conditions permit, a very satisfactory guard is made by plowing two or three furrows about the plantation close to the trees and then making a second series of furrows from one to two rods outside the first. These lines may be kept free from vegetation by replowing each year or they may be used for crops that do not easily burn. The space between the two series of furrows should be kept free of all combustible material by burning it over at safe times.—(Y. B. 1895; F. S. Cir. 54.)

FENCE-POST TREES.

A forest plantation may often serve both as a woodlot and as a shelterbelt for crops, stock, and farm buildings. If trees suitable for fence posts are grown, they will furnish the desired protection and also yield a salable product. The best species for post production are chestnut, European larch, catalpa, black locust, Osage orange, and Russian mulberry. None of these trees should be used except within their economic planting range and on soils adapted to their growth. In States where several of these trees can safely be planted, the choice will naturally fall on the best grower or the one that will meet the special need of the owner. Elsewhere other less valuable species may be preferable because of their hardiness. Thus, in the semiarid region where other species would not thrive, green ash and honey locust have been grown with good results. These woods are fairly durable if well seasoned. White willow also has been extensively grown for fence posts over a broad region in the Middle West. It has the advantage of unusually rapid growth, and the seasoned wood lasts several years. But the use of any of these species is unwise where more durable trees can be grown. The advisable planting range of the species recommended above is as follows:

European Larch.—Well-drained sites in New England, New York, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Michigan, Wisconsin, Minnesota, and the eastern parts of the Dakotas and Nebraska. *Hardy Catalpa.*—Deep, fertile soils with sufficient moisture and good drainage in Ohio, Indiana, Illinois, Iowa, Missouri, eastern Nebraska, eastern Kansas and eastern Oklahoma. *Osage Orange.*—A variety of soils in the central and southern portions of Ohio, Indiana, Illinois, Iowa and eastern Nebraska; favorable situations in western Nebraska, Kansas, and Oklahoma, eastern Colorado, and New Mexico. *Black Locust.*—Well-drained soils from the Rocky Mountains to the Atlantic coast; but in the Dakotas, Kansas, Nebraska, Iowa, Illinois, Indiana, Ohio, and Pennsylvania planting is wholly or partially prevented by injuries caused by the locust borer. West of the Rockies the black locust has been planted to a limited extent with marked success and with entire immunity from the attacks of insect pests. *Russian Mulberry.*—Kansas, Oklahoma, and the Indian Territory. Useful in those localities where better species can not be grown.

Planting.—When the proper species has been selected, the second essential is the careful performance of every detail of the planting operations. In the prairie States it is usually necessary to prepare the site as for a field crop. Hardy catalpa needs thorough soil preparation, regardless of the region. Care and promptness must be exercised in setting the trees. The stock should be planted as soon as possible after it is on the ground. The roots of all the young trees must be kept moist and the planting done carefully and thoroughly, with special attention to packing the dirt firmly around the roots. Even after a wise choice of trees, failures frequently result from improper handling and careless planting. If post production is the primary object, any of the species mentioned may be planted pure; if it is secondary, mixtures, such as chestnut with oaks, or larch with pines, oak, or chestnut, may be used. The best spacing distance depends largely upon the species and upon the local conditions of soil, topography, and annual rainfall. Generally speaking, the trees should be spaced from 4 to 6 feet apart each way, but in the prairie States of the Middle West, where cultivation is necessary, a spacing of 3 or 4 feet in rows 6 or 8 feet apart is often wise.

Cultivation and Care.—After the planting has been done, plantations in the prairie States should receive careful cultivation several times each season for two or three years. Loosening the ground and forming a dust mulch retards evaporation and protects the trees from encroaching grass. Unless the soil is carefully cultivated, forest plantations in many situations will almost immediately fail. Hardy catalpa plantations should always be cultivated. To secure a straight, clean sprout for the main stem, such trees as hardy catalpa, Osage orange, Russian mulberry, and locust may be cut back to the ground during the winter of the second year after planting. During the first season of sprout growth one good, tall sprout should be chosen and the rest cut off. In this way the tendency to irregular and crooked growth may be avoided. To force them into good proportions for fence posts, trees like Osage orange and Russian mulberry should, except when in shelterbelts, be kept well pruned of low side branches. The hardy catalpa sheds its dead branches very slowly, often letting in decay. It is therefore advisable, if the best results are desired, to keep the dead limbs trimmed off.

Cost and Returns.—Two hardy plantations were established in Pawnee County, Nebr., in 1890 and 1889. By contrast, they show well the possibilities and limitations of the species. No. 1 was planted on well-prepared virgin prairie soil; No. 2 on adjacent worn-out farm land. The soil was a deep, sandy loam underlaid with clay. The plantations received cultivation and pruning at the proper time.

PLANTATION NO. 1.

Cost per acre.		*Returns per acre.*	
Plants, 2,722 at $1.15 per thousand	$ 3.13	First-class posts, 647 at 14 cents	$ 90.58
Preparation of the ground, cultivation, and pruning	18.46	Second-class posts, 1,363 at 9 cents	122.67
	$21.59		
Interest on $21.59 for 14 years at 5 per cent interest compounded	$21.16		
Total cost at end of 14 years	$42.75	Total returns at end of 14 years	$213.25

Net profit per acre, $170.50.

This profit represents an annual net return, with 5 per cent compound interest, of $8.69 per year.

PLANTATION NO. 2.

Cost per acre.		*Returns per acre.*	
Plants, 2,722 at $1.15 per thousand	$ 3.13	First-class posts, 18 at 14 cents	$ 2.52
Preparation of the ground, cultivation, and pruning	18.46	Second-class posts, 510 at 9 cents	45.90
	$21.59		
Interest on $21.59 for 15 years at 5 per cent interest compounded	$23.29		
Total cost at end of 15 years	$44.88	Total returns at end of 15 years	$48.42

Net profit per acre, $3.54.

This profit represents an annual net return, with 5 per cent compound interest, of $0.16 per year. Five years' additional growth would show a much greater proportionate return.—(F. S. Cir. 69.)

The original cost of preparing and establishing a plantation ranges, according to local conditions, from $8 to $15 per acre. This does not include the expense of any subsequent treatment, such as cultivation or pruning. The conditions of the site, the method of planting, and the care which has been given the plantation all materially affect the yield. Larch, hardy catalpa, and Osage orange should in fifteen years yield from 500 to 1,500 posts per acre. Plantations growing under excellent conditions have at this age yielded as high as 2,000 posts per acre. If the site and species have been wisely selected and proper care has been exercised in planting and culture, profitable returns may be expected from forest plantations for post production. In addition, the convenience of a home supply of posts and stakes, and the protection afforded by the trees, enhances the value of the plantation. The exact amount of profit must depend, however, on the yield of posts per acre and the prices obtainable, which vary greatly in different localities. Examinations of larch plantations in Illinois, Iowa, and eastern Dakota showed that the annual financial returns per acre were approximately as great as from field crops properly managed, and the plantations required less care. In Illinois, also, hardy catalpa plantations on suitable soils gave returns equal to or somewhat greater than the usual farm crops.

ECONOMIC LUMBERING FOR THE SMALL LANDOWNER.

The following is intended chiefly to apply to small bodies of mixed hard woods. Usually it is desirable to have some definite idea as to the quantity of timber standing on the particular tract of land. In most cases, especially if the timber is of large size, it is best to make a complete inventory, excluding, of course, all young and useless trees. For this purpose the trees are counted, the different kinds of oak, ash, etc., being kept separate, and for each tree the following dimensions noted: Diameter (inches) breast high, measured; diameter at top of saw-size timber, estimated; total height of tree (in feet), estimated; length of saw timber, estimated.

From the figures thus ascertained, the volume of the saw timber is obtained by taking one-half the sum of the upper and lower diameters, squaring, multiplying by the length of the timber (taken in feet), and dividing by 16, the result being the amount of lumber wood in board feet. Of this about one-half must be deducted in ordinary hard woods for bark, slab, saw waste, crooks, and other defects. The approximate total volume of each tree may be estimated by multiplying the area of the cross section (breast high, taken in inches), with half the total height of the tree taken in feet, and dividing by 144, the result being in cubic feet. Converted into cord wood, it requires 75 to 100 cubic feet of this solid measure to make a cord, or 128 cubic feet in the pile. In thickets of pole wood the amount of cord wood is often best estimated by counting the trees on a given area and noting how many 4-foot pieces an average tree will make, keeping in mind that it takes about 175 large-sized pieces, 200 medium or mixed, or else about 225 to 250 smaller pieces to make a cord.

Where considerable tie timber stands, the trees are best kept separate, noting for each how many ties it will furnish. Generally, trees under 12 inches in diameter are best left standing, unless they have special value for wagon or turner's stock, or else may be used for pulp. Special sizes or special kinds, such as walnut, cherry, yellow poplar, may often be sold in the log either to special manufacturers or else for export. Generally, this is not profitable. The bulky logs cost much to handle, and the buyer will deduct all wastage to the disadvantage of the timber owner. In nearly all cases a sawmill of some kind is indispensable. This need not always be large; sometimes a portable mill worth $1,500 to $2,000 answers very well, and in some cases an arrangement may be made with a conveniently located neighborhood mill, although this commonly divides the interests to a troublesome degree. The logging is usually best done in late fall and winter; labor is then more abundant, transportation locally facilitated by snow, and the danger from fungi, causing discoloration and decay, as well as from boring insects, is at a minimum. Where this is not practicable, or where the bark is to be utilized, as in oak, all timber (cut in spring and summer) should be worked up as fast as cut, and any logs not at once sawed or split should be peeled, raised off the ground, and their ends painted. The particular product to be sawed depends on many circumstances. Along railways oak timbers are usually salable as sawed bridge and switch timber, car sills, etc., and timber of this kind deserves special attention, since it involves less labor in conversion and leaves little waste. All larger timber, especially of beech, birch, maple, chestnut, etc., may be cut into lumber, care being had to saw according to the quality of the log, for it is wasteful to saw a good log in a careless manner. Where sawed axles, bolsters, tongues, and other wagon stock are in good demand, these may be made, and rarely, in good timber, does careful quartersawing fail to pay for the extra labor involved. Whether the lumber is to be 1-inch or 2-inch stuff depends on the nature of the market and the wood, and a careful inquiry into what the dealer or consumer wants is in all cases of the utmost importance. The butt cuts of hickory, ash, elm, oak, and locust usually bring special prices as wagon and carriage wood, and therefore should be worked up into spokes and fellies, and otherwise shaped to suit the particular case. Where the market warrants, white oak may be split into cooperage stock, hickory into chair rounds and handles, birch sawed for spool wood, maple for all kinds of turner's materials, walnut for gunmakers, and much light wood is profitably converted into "shooks" or small boards, usually cut five-eighths of an inch thick.

Many of the smaller woods, such as dogwood, hawthorn, and others, may be sold to the turner and cabinetmaker, and at all times burls, curly, birds-eye, and other specially valuable forms should receive attention. Smaller timber is preferably worked up

Virgin Stand of Douglas Fir, Cedar and Amabilis Fir. Olympic National Forest.

into railway ties, for which only the more durable oak, chestnut, and locust are suited. Long, straight trees, especially of chestnut, are always in demand for telegraph and telephone poles, which however, cause considerable trouble in handling and transportation. Tops and other refuse should be cut into cord wood, even if little more than expense is safely covered, for even in this case it furnishes employment and removes rubbish, which is always a nuisance and frequently a danger to the young growth, which should be left standing. Effort should be made to utilize all kinds of trees and all parts of every tree. Generally, it is easier and safer to convert trees into lumber only, since this is always salable, the largest trades all using wood in this form, but it is often more profitable to attend to the wants of other consumers and prepare wood for special uses, and even where this is not the case it may promote a more perfect utilization of all the material. In this connection attention may be called to one of the common mistakes made by small concerns. It consists in neglecting both proper selection and care. The good should always be kept with the good, for it does not pay to sell the good with the bad, and in no case is it profitable or even excusable to spoil good lumber by bad piling, as is often done on unsuitable, damp ground, with no care as to ventilation or cover. A fair profit may easily be converted into a serious loss by neglecting to care for the board after it is made. In oak timber the bark will usually prove a valuable source of revenue as tan bark. It should be peeled off in the spring and carefully dried, preferably under cover, since it molds if damp, and is also injured by rain.

An illustration of what may be done by careful, systematic management is shown in the following particularly interesting case of timber exploitation, in no feature imaginary or theoretical, but actually carried out a few years ago: Forty-three acres of well-stocked, rough timber land in eastern Pennsylvania were bought for $5,800, together with 48 acres of improved farm land, for which $2,500 additional was paid. A portable second-hand mill was purchased for $1,000; mill shed and shanties were erected, and this outlay, together with all the wages (nearly $4,000) and cost of hauling, railway and canal freights (little over $4,000), brought up the total outlay, land included, to $18,855. As the mill was at once set in operation, some income was derived from the first, thus obviating the necessity of considering the interest on the several expense accounts. The following represents the cut from these 43 acres made in just two years, with only the partial personal attention of the owner and without the employment of a special superintendent:

Amount and value of articles and lumber sold.

Miscellaneous:	Sold for.
111 tons of oak bark	$1,224
801 cords of firewood	2,640
196 telegraph poles	500
16,800 hickory spokes	388
66,000 feet slabs (running measure), used largely in mines	333
For custom sawing	130
Sawdust	7
Total	$5,222

Lumber (board measure):			
Hickory butts (bought by paper mill for cogs)	feet	9,680	
Birch, sycamore, and second-cut hickory (sold to toy concern)	do	11,822	
Ash	do	957	
Walnut	do	3,414	
Yellow poplar	do	12,941	
Gum	do	1,386	
Maple	do	1,042	
Chestnut	do	34,719	
Oak	do	162,552	
Total		238,513	$ 6,522
Railroad ties	number	9,345	5,282
Switch timber	linear measure	6,217	821
Other materials			654
Total			$18,501
Place and mill were then sold, the former at $4,623, the latter at $1,000 making a total of			$24,124
Against an expense of			18,855
Leaving a profit of			$ 5,269

Here was a tract of 43 acres of timber with a yield of less than 16,000 feet, B. M., per acre as ordinarily estimated; a stumpage of about $5 per 1,000 feet, and a profit of over $100 per acre. While it is not possible to repeat this everywhere, it goes far to explain why good hard wood timber in eastern Pennsylvania and New Jersey sells at $100 to $150 per acre when farm land does not bring one-half as much, while only 30 years ago the case was exactly the reverse and the farms were rated by the amount of cleared land. It also shows how, at least in a large part of the eastern United States, woods may be exploited in a careful instead of a wasteful manner, and how many a small holder, who can give the matter his personal attention and do much of the work at odd times, may make his wood lot a source of revenue. In this case the object of the purchasers was simply to take from the ground and put into their pockets the money value which had been accumulating in the wood for centuries; and this they did without regard to what became of the ground after the crop was harvested. It was a speculation.

The farmer who owns his property not as a speculation but as an investment should go to work very differently in exploiting his wood lot. He should first determine whether his wood lot stands, as it should, on the poorer portion of the farm—the portion least fitted for agricultural purposes by reason of its rocky condition, its poor or thin soil, the steepness of its slope, or its location on a slope or hilltop where it helps to regulate the waterflow and prevent the washing of soil, etc. If it is so situated, and if therefore it is proper policy to keep the ground for forest crops—the only crops which can be profitable in such situation—then the cutting of the mature virgin timber should proceed in such a manner as to secure a desirable reproduction of the same, so that when the old crop is harvested a young crop is taking its place.—(Y. B. 1896.)

THE PRESERVATIVE TREATMENT OF FARM TIMBERS.

In many localities the need for the preservative treatment of farm timbers is imperative. Throughout wide areas the advisability of using creosoted posts is indisputable. In spite of these facts it is often difficult for a farmer efficiently to treat his own material with preservatives. This, however, does not indicate that the work should be neglected. Rather it points to some different means of securing the desired result. There are two practical methods of doing this. One is for some individual to undertake the work for the neighborhood. A small wood-preserving plant could be profitably operated in connection with a thrashing outfit, a feed mill, or sawmill. The other plan is for several farmers to cooperate in establishing and operating the plant. As an indication of the success which should attend such an undertaking the cooperative creameries of various sections of the country may be cited. The means, then, may vary, but it can not be too strongly emphasized that every agricultural district should possess the facilities for increasing, by preservative treatment, the durability of farm timbers locally used. The decay of farm timbers is caused by the destruction of the wood tissues by low forms of plant life. It follows that the object of all preservative treatment is to prevent the development of these organisms, and that the most effective treatment is the one that accomplishes this for the longest period.

These organisms require for their best development a certain balance between the air and the moisture content of the wood, and a favorable temperature. Thorough seasoning, on the one hand, or thorough saturation with moisture on the other, alters this balance to such an extent that the growth of the organism is either retarded or prohibited. Air seasoning only retards the growth.

There are several methods by which timbers may be given more thorough preservative treatment. The surface of the wood may be soaked with paint or some similar substance. Such a coating keeps the wood dry, and more or less effectually excludes the entrance of the decay-producing organisms. Such coatings, however, should be applied only to well-seasoned material, since they will also tend to retard the escape of such moisture as may be already within the timber. Better preservatives are the products of the distillation of coal tar and petroleum tar, which, in addition to possessing the advantages of paint, are antiseptics and poisonous to fungi. The deeper such antiseptics penetrate the wood the more lasting is their effect.

It is well known that wood decays most rapidly when placed in contact with the surface of the ground, because the wood-destroying organisms find there more uniform conditions of heat and moisture to encourage their development. For this reason the ground line of a post must be thoroughly treated, whereas portions of the post above and below this point require less treatment. The climate of the locality should also be considered. In the warm Gulf States or in a moisture-laden atmosphere posts require more thorough treatment than in a cooler northern climate or on the arid plains.—(F. S. B. 78.)

Prolonging the Life of Posts.—The usual methods of prolonging the life of fence posts are considered in the order of their efficiency, beginning with the cheapest and least effective. One point deserves special emphasis, namely, that in spite of the high first cost, the best treatment is the most economical in the long run. The study upon which this publication is based indicates that impregnation with creosote is decidedly the best preservative method. The value of seasoning has already been explained. It is likewise important to remove the bark, so that the outer layers of the wood may dry more thoroughly.

A preservative method, akin to seasoning, consists in piling stones or similar material around the base of the post. This checks the growth of weeds and permits the air to circulate more freely around the post. It is doubtful, however, whether the saving justifies the cost. Good results have been obtained by charring the post over an open fire. The wood must first be thoroughly seasoned, and care must be taken not to let the wood "check" or split from the heat. Too deep charring, which will weaken the post, must obviously be avoided. In some cases it is unnecessary to char the entire post, but the burning should always extend 1 foot above and 1 foot below the ground line. It is often a good plan to char the very top of the post. Treatment with the brush should be resorted to only when more efficacious methods are impracticable. If brush treatments are to be effective, the posts must have been thoroughly seasoned, or the surface coating will afterwards be broken by the opening of seasoning checks through which moisture will enter the wood. At best surface coatings are not very durable. Some of the substances which may be applied with a brush are whitewash, petroleum-tar creosote, coal-tar creosote, and various patented products of coal tar and petroleum tar. Paint and whitewash are inferior to antiseptic preservatives; products of coal tar (creosote, etc.) are the best. These are best applied hot, in two or more coats. A barrel (50 gallons) of creosote should be sufficient to paint at least 300 posts with three coats for the butts and two for the tops. One defect of brush treatment is that the preservative does not enter readily the cracks and checks. This defect may be overcome by dipping the posts in the preservative. Another advantage of dipping, as compared with painting, is a saving in labor. On the other hand, dipping requires a larger quantity of preservative, and, in addition to the amount consumed, there must be enough surplus to keep the barrel or tank filled to the proper depth. This usually forbids the use of any expensive preservative for dipping. Petroleum tar, coal tar, and the creosotes, however, may often be advantageously employed. Posts have been treated by dipping the butt in cement. This is hardly satisfactory, owing to the ease with which the protective covering may be broken; moisture is absorbed after treatment and causes the wood to expand and crack the cement.

The treatments thus far considered merely coat the surface with a preservative. Penetration or "impregnation" of some woods is secured by prolonged soaking (a ten-hour bath) in the preservative at ordinary air temperature. This method of treatment is attractive in many cases, because it is so simple. Nevertheless, far betters results are obtained in all cases by the use of a hot bath as well as a cold bath. As a rule only the cheaper preservatives can profitably be used in the cold-bath treatment, for the same reason as in dipping. Coal tar is so ropy and sticky that it will scarcely penetrate even the most easily treated woods. Crude petroleum enters the wood rather readily but lacks strong antiseptic qualities. A long bath in crude petroleum may, however, prove a feasible method of treatment where petroleum is very cheap and the woods used are readily impregnated. Creosote is usually the best preservative to employ. Coal-tar creosote requires a slight heating to liquefy it. Water in the wood cells resists the penetration of the oil. Thorough seasoning before treatment is, therefore, necessary to allow the oil to penetrate readily and to prevent checking after treatment. The cold-bath method of treatment has not yet been thoroughly investigated. It is probable, however, that it will impregnate but few woods. The woods which are likely to prove most suitable are beech, cottonwood, the gums, pin and red oaks, the pines, sycamore, and tulip tree.

Impregnation With Creosote.—The impregnation of fence posts with creosote is best accomplished by the so-called "open-tank" process. This consists of heating the wood for a certain period and then cooling it in the preservative. The principle is simple: During the heating the high temperature causes the air and water contained in the wood cells to expand, so that a portion of this air and water is forced out. The rest contracts as the subsequent cooling progresses, and a partial vacuum is formed, into which atmospheric pressure forces the cool preservative.

The open-tank principle may be variously applied in the treatment of posts. The best way to heat the posts is to immerse their butts in creosote maintained at a temperature of 220° F. If a single tank is used the cooling bath may be given by permitting the temperature to fall, and in this case the preservative must, of course, be used for the hot bath. It is better, however, to employ an additional tank containing the cold preservative. If two tanks are used and a thorough impregnation of the top of the post is desired, the cold-bath tank should be large enough to permit the soaking of the entire post. The top of the post will not be too heavily impregnated, because it has not been immersed in the hot oil. Creosote is usually the most satisfactory preservative. With two tanks crude petroleum or any heavy (high-boiling) oil may be used in the hot-bath tank.

Preparation of the Posts for Treatment.—For treatment with creosote some importance attaches to the size and the form of the posts. The removal of the bark and the seasoning of the wood before treatment are essential for success. At present many posts of large size are used in order that the strength of the fence may still be sufficient after decay has progressed for several years. Obviously such large posts are unnecessary if proper preservative treatment is given and, since the cost of treatment increases rapidly with the size of the post, there is much advantage in using comparatively small ones. For instance, a well-treated line post need not exceed 5 inches average diameter.

The form of the post, whether it is round or split, may influence the efficiency of the treatment. A split post necessarily has heartwood exposed to the air. With some woods this is immaterial; with others the heartwood can not be impregnated, and untreated heartwood will prove inferior in durability to properly treated sapwood. Therefore, only round posts of the latter class should be used. In general, the heartwood that is highly colored, such as that of oak and yellow pine, is practically impenetrable.

The tops of the posts should be cut obliquely to shed rain water. A bevel made with an ax is preferable to one made with a saw, because it is smoother. Beveling is particularly important if the tops of the posts are not to be treated. Bark retards or prevents the penetration of the preservative into the wood. It also uselessly increases the cost of treatment by itself absorbing oil. Peeling the posts before treatment is, therefore, necessary. Even the papery inner bark should be carefully removed, especially in the case of pine and basswood. Thorough seasoning should always precede impregnation. Even air-dry wood is unfit for treatment after a heavy rain, and when thus saturated should be permitted to dry for at least three days of good seasoning weather.

Under favorable conditions the average period required to season posts is five weeks, but this period varies widely, according to the kind of wood, the season of the year, and climatic conditions. A simple method of determining the degree of seasoning is to weigh a few representative posts every few days. As a rule, an air-dry condition is reached when the loss of moisture is less than 1 pound per post (of 5 inches average diameter) during five days of good seasoning weather.

Application of the Preservative.—It is well known that different woods vary greatly in weight and strength. They also differ considerably in the ease with which they absorb the preservative; so that each species requires a different treatment if best results are to be obtained. In the experiments conducted by the Forest Service and its cooperators the purpose has been to determine the best treatment for various woods. The investigations have also indicated the relative ease of treatment of the different woods. Two methods of treating were employed. In some cases but one tank was used, and only the butts of the posts were impregnated, though two tanks were used in creosoting most of the woods. In the second method only the butts were immersed in the hot bath, while the whole posts were submerged in the cold bath.

Most species will absorb too much creosote if a very long treatment is given. Therefore, to make the treatments economical the absorption must be limited to 0.4 gallon per post if only the butt is treated, or 0.6 gallon per post if the top also is impregnated. The best treatment is that which will give, with a reasonable absorption, the deepest possible penetration of the oil into the wood in the shortest time.

Woods which are naturally durable in contact with the ground, such as cedar, locust, white oak, and black walnut, were also included in the experiments. In general, a heavy treatment is required to impregnate their sapwoods, and their heartwoods can not be successfully treated. Though preservative treatment somewhat prolongs the life of these species, they are not only too expensive to be treated with economy, but even without treatment they are likely to cost more than cheaper and equally satisfactory posts that can be had by creosoting an inferior wood.

In California, posts of different species of eucalyptus were creosoted. A three-hour bath in hot oil was a sufficient treatment for green posts, but the oil penetrated very irregularly. When the posts were inverted after butt treatment, the free oil followed the large ducts in the wood and appeared on the top of the post. A few tests also were made on quaking aspen, boxelder, Douglas spruce, and silver maple. Quaking aspen will probably require a treatment similar to that recommended for cottonwood. The heartwood of Douglas spruce is impenetrable by open-tank treatments, but the sapwood may be easily impregnated. Boxelder and silver maple absorb creosote readily, but the penetration at the ground line is relatively small. Therefore, whenever a choice of species is possible, only the woods best adapted to preservative treatment should be used.

The procedure in treating may be summarized as follows: (1) Raise the temperature of the hot bath to 220° F. before putting the posts in the tank. Maintain this temperature throughout the bath. Have sufficient oil in the tank to submerge the butts 6 inches higher than the ground line when the posts are set. (2) If only one tank is used, the oil will be absorbed by the posts during the cooling bath, and more should be added to keep them submerged to the proper depth. (3) If two tanks are used, liquefy the cold bath by heating. The best temperature is from 100° to 120° F. Transfer the posts from the hot to the cold bath as quickly as possible. At least that portion of the post which has been heated should be immersed quickly in the cold bath.

Cost of Treatment.—General cost figures are valueless, but the cost under any specified conditions may be readily ascertained. Apparatus and oil are the two most important items of expense. The charge per post for the apparatus should not exceed 1 cent when a serviceable outfit is used and its permanency is considered. Labor and fuel charges are usually ignored in fence-post treatments, and hence are omitted in the examples of cost given below. If, however, it is desired to include them, the number of posts treated daily is important. Of course the size of the post affects the cost.

The cost of creosote by the barrel varies widely according to locality. In the Eastern States it costs 12 to 15 cents per gallon;

on the Pacific coast, 15 to 20 cents; in certain localities in the Rocky Mountain region it is as high as 30 cents. In the table the absorption of oil per post is stated for the recommended treatment. To this must be added a certain quantity of oil which evaporates from the hot bath. The amount of creosote which evaporates depends mainly upon the grade used, but 20 per cent of the absorption is accepted as the average. The quantity of oil consumed per post is, therefore, one and one-fifth times the absorption.

Value of Treatment.—In portions of Maryland locust posts cost 35 cents a piece, and are difficult to obtain even at this price. A pine post, treated in the manner recommended will doubtless equal one of locust in durability, and will cost only half as much. In the prairie region of Minnesota willow posts of sufficient size to last fifteen years cost 25 cents. Creosoted cottonwood posts could be substituted for these, and would be considerably cheaper as well as more durable. In sections of Idaho lodgepole pine posts are extensively used. The following illustrates the annual saving affected by creosoting such posts:

	Untreated	Treated
Initial cost of post	$0.06	$0.06
Cost of treating post	.00	.15
Estimated cost of setting post	.12	.12
Total cost of set post	.18	.33
Estimated length of service	4	20
Annual cost of post (allowing 6 per cent interest on investment) approximately	$0.05	$0.03
Annual saving per post treated	....	.02

In general, it may be said that any post properly creosoted will last twenty years. To determine the exact length of life under various conditions, posts experimentally treated are being tested in fences, and detail maps on which each post is numbered are made to record the kind of post and its treatment. By means of such maps it is possible to study the durability of the individual posts and the effects of various treatments under different conditions.

Prolonging the Life of Shingles.—Wood used on the farm in various forms other than post material may often be advantageously preserved from decay by chemical treatment. The results obtained assuredly justify the cost of treating all timbers used in foundations, sills, beams, and planking, as well as the lower portions of board fences, and the lumber used near the ground in sheds and barns. The treatment of these is very similar to that given posts. Shingles, however, form an important special class of material.

With the grades of shingles obtainable nowadays exposure to rain and sun commonly results in warping or curling. Water absorbed during a storm subsequently evaporates rapidly from the upper surface and rather slowly from the lower surface. Consequently, the upper part of the shingle shrinks more than does the under, and curling or warping results. The importance of excluding moisture is obvious. In addition to this, it is advisable to employ an antiseptic to retard decay. The best preservative, it follows, must possess such qualities as will operate in both these ways to prolong the life of the shingles. The necessity of applying preservatives only when the wood is thoroughly dry may again be emphasized.

Nonantiseptic Preservatives.—The application of paint is the preservative measure most commonly used with shingles. The method of applying it is of paramount importance. Dipping the shingles individually is the only satisfactory procedure. When a roof is painted ridges of paint are formed at the bases of the shingles, owing to the irregularities of the surface over which the brush passes. These cause the water to permeate the crevices between the shingles and frequently hasten decay.

Antiseptic Preservatives.—The best antiseptics for shingle treatment are creosote and other derivatives of coal tar. Painting the roof with these oils is a rather satisfactory method of treatment, since the coal-tar derivatives penetrate the shingles better than ordinary paint and do not leave ridges below the base of the shingles. At least two coats should be applied. Dipping the individual shingles gives good results. The best results are, however, obtained by heating and cooling the wood in the preservative, as described for the treatment of fence posts. Sap loblolly pine shingles may be thoroughly impregnated by means of the open-tank process. This method is the best even for woods which resist the penetration of the oil; for example, white cedar. Its advantages are two-fold—the shingles can be treated in bundle form, and, with proper treatment, the surface of the wood will be free from surplus oil.

The open-tank process has already been explained. The apparatus used for posts may be employed, or if shingles exclusively are to be treated the form of the outfit may be modified. The simplest apparatus is a single tank large enough to hold a bundle of shingles. If a larger capacity is desired, the depth rather than the width should be increased, for, in order to minimize the loss from volatilization, the oil surface exposed to the air should be kept as small as possible. The best treatment for various kinds of shingles has not yet been determined. The proper length of treatment may, however, be readily decided in any particular instance by weighing the shingles before and after treatment. An absorption of 12 or 13 pounds per bundle, or 6 gallons per thousand shingles, is advisable. The cost of treatment per thousand shingles should range from $1.25 to $1.50. In order that the deepest penetration compatible with this absorption may here be secured, the heating should be relatively long.

Creosoted shingles possess certain objectionable qualities, though none which prohibit their use. Among these may be mentioned their strong odor and their contamination of cistern water. Further, since the shingle nails become covered with creosote and can not be held in the workman's mouth, it is said to be more difficult to lay these shingles. The odor, however, disappears in the course of a few weeks—two weeks in one case observed; the contamination of the cistern water is also of short duration—in one instance the water was tasteless after three days of rain; and, in any case, the water from a newly creosoted roof can be diverted from the cistern for a week or so, or until there is no danger of making the water taste, and the use of a shingle-nailing machine obviates the difficulty in laying the shingles. All these objections are removed if the shingles are seasoned for a few weeks between treating and laying.

It is impossible to paint creosoted shingles satisfactorily; hence, if the brownish shade of the creosote is deemed undesirable, it is necessary to stain the shingles during the preservative treatment. Of the common colors green pigment is expensive and red and brown are cheaper. Further, it is necessary to use a comparatively large quantity of green to obtain a satisfactorily colored creosote, while a relatively small amount of red or brown pigment suffices. For these reasons it is not feasible to stain shingles green by the open-tank method of creosoting, and brush treatment or dipping must be resorted to. The latter two methods may also be used with a variety of patented stains containing creosote. To obtain a red or a reddish-brown creosote 8 to 12 ounces of "color ground in oil," mixed with an equal bulk of linseed oil, should be used for each gallon of preservative.—(F. B. 387.)

FARM FORESTRY IN THE UNITED STATES AND CANADA.

Leaving out those planting problems which are of such magnitude that they must be handled by the State or by large companies, the farmer's part, in the northern forest, will be confined to the restocking of farm woodlots in the various agricultural districts and to the reforesting of abandoned farm lands in New England.

The New England landowner is realizing more and more the fact that although portions of his farm may be "run out" or too rocky to compete with the better agricultural land of the West in the production of annual crops, yet they offer a splendid opportunity for a very safe and satisfactory investment in timber growing, and wherever the farm includes sufficient good agricultural land to furnish the necessary annual income, the remainder should, by all means, be devoted to a forest crop.

Aside from extensive pitch pine plantations on the sandy areas of the Cape territory of Massachusetts and the islands of Marthas Vineyard and Nantucket, more than 90 per cent of the planting in New England has been with white pine. Other conifers which under suitable conditions have been successful are Norway spruce and European larch. Mature plantations of hardwood are comparatively rare.

The state governments of Connecticut, Massachusetts, and Vermont distributed about 1,500,000 seedlings in 1908, and these did not supply the demand. One private firm disposed of a million seedlings. Beginning with the spring of 1907, the state nursery of Vermont started in to distribute about 100,000 seedlings a year.

Almost every farmer in Vermont may wisely do a certain amount of planting under the direction of the state officials. The most hopeful places for beginning the practice of forestry are the old, weedy back pastures which are now lying waste. Next in importance to these come the blank spaces in natural stands, which should be filled in.

White pine is considered the best, though red-pine is of great value, especially for the drier soils, and the Vermont experiment station is using Scotch pine on dry sands. Norway spruce is of especial promise for the moist, strong land of the high mountain valleys—natural spruce land. Small plantations of black locust are being tried for supplying durable posts and stakes.

The conifers best adapted for planting, particularly on the sand plains, are Scotch pine, white pine, Norway pine, and pitch pine; and the hardwoods which promise best are chestnut, red oak, locust, and sugar maple.

The increasing field for forest planting in the New England States is strikingly indicated by the recent increase in the area of unimproved land in farms. There was 11 per cent less improved farm land in Maine in 1900 than there was in 1890, and 20 per cent less in New Hampshire, with the other New England States between these two figures. In all, there are 2,500,000 acres in New England that need planting.

In New York State the species which are best adapted and which promise highest returns are white pine, red pine, Norway spruce, chestnut, red oak, basswood, tulip poplar, white ash, and, in moist places, Carolina poplar. Forest planting is increasing rapidly. The work of the State in the Adirondacks is a remarkably fine example of good nursery practice and planting, and active steps are being taken by the state authorities to encourage forestry among the farmers and other landowners.

Pennsylvania divides readily into three sections where conditions of surface, soil, and climate are greatly enough differentiated to modify the practice of planting for each. The southeastern plain extends from tidewater along the Delaware westward and northeastward along the Blue Mountains, which form the northern boundary of Cumberland, Lebanon, Berks, Lehigh, and Northampton counties. The central mountains comprise a broad belt extending from the northeastern part of the State southwest to Maryland and West Virginia. The western hills include a section in the northwestern part of the State extending from the Allegheny River westward to the Ohio line and Lake Erie. The second-named region was covered originally with splendid forests of pine, hemlock, and hardwoods. There is relatively little need for planting in this region, so the greatest opportunities for farm forestry are in the other two sections. The southeastern plain was an early settled farming region, and nearly every farm had its woodlot. Very few of these woodlots are now in good condition, though in some cases the owners have become interested in reforestation, and more or less tree planting has followed. The average prices of cordwood, fence posts, and farm repair material are higher in this than in any other portion of the State. This fact, coupled with the value of the land for agriculture, makes this region a splendid field for farm planting where quick-growing species will produce fence posts and other timber in a comparatively short time. Though more planting has been done in this section of the State than in any other, the early purposes of planting were rather vague. Two kinds of timber were planted. Of these white pine leads in the class of slow growers and black locust of the rapid growers. No great degree of success has been attained and the value of the early planting has been mainly educational. The great area of the near-by central mountain region, which is more valuable for trees than for any other crop, makes it desirable to devote woodlots on these plains to rapid-growing species. Those which seem to give the best promise are red oak, European larch, tulip poplar, and, where preservative treatment can be given, cottonwood, silver maple, white willow, loblolly pine, and pitch pine. Catalpa has proven successful enough to justify its limited use on rich soils, and with proper methods of growth it should prove a valuable post tree.

Where planting is needed in the central mountains the species used should be white pine and spruce, and hardwoods such as red and scarlet oaks, tulip poplar, white ash, and basswood.

The western hill section ranks next to the southeastern plains in agricultural value, yet contains a much larger proportion of land adapted to trees. Here planting will add to the general value both of the farm and forest areas. Since there are considerable areas of essentially nonagricultural land separating the agricultural sections, slower-growing species for the production of large timbers will be profitable, while, as on the southeastern plains, quick-growing species may be planted to advantage on many of the farms. Thus far, however, very little planting has been done. In the western hills the soil is admirably adapted to white pine, European larch, and hardwoods such as red, yellow, and scarlet oaks, white ash, basswood, honey locust, and rapid-growing species such as cottonwood, soft maple, and white willow, to be used in connection with preservatives.

In New Jersey forest planting is rapidly increasing. For timber production the species which have been chiefly planted are white pine, Scotch pine, white ash, and white elm, though species which give the best promise are the rapid-growing pines and spruces.

In the Lake States, which have a southern hardwood forest and a northern coniferous forest, forest planting is rapidly increasing. The principal species which have been planted are white pine, Scotch pine, Norway pine, European larch, and, to some extent, the more rapid growing hardwoods such as locust, catalpa, black walnut, cottonwood, ash, and elm. As in the East, woodlots are deteriorating and require interplanting. Excellent trees for this purpose are the white pine, the Scotch and Austrian pines, and the Norway spruce. The rapid-growing hardwoods which make such an excellent investment farther south can not be successfully grown in this northern region.

Hardwood Forest.—In the States included within the great central hardwood forest region the sort of planting which should chiefly interest farmers will have for its object the utilization of waste land on the farm. In those States which are making the most rapid general progress the state authorities are issuing publications that contain advice and information, are distributing stock from state nurseries, and are conducting forest work on state lands, which serve as an object lesson to private landowners. In the farming region east of the Appalachians in Virginia, Maryland, and Delaware most of the land is too valuable for agricultural purposes to be devoted to timber growing. As in other farming regions, however, every farm should have its woodlot, and in many localities where no extensive timbered areas remain the planting of windbreaks and shelterbelts is advisable. A recent study of conditions in Delaware indicates that the growing of timber crops, without considering the value of forest belts from a protective standpoint, is an excellent investment on lands worth not more than $15 per acre. Portions of farms which have been worn out through continued cultivation may be planted to advantage. The species recommended for planting in Delaware are chestnut, red and pin oak, tulip poplar, and black locust. The last-named tree will do well on sandy soils not only in Delaware, but throughout Maryland and Virginia. There is one drawback, however, to a locust plantation, and that is its well-known enemy, the locust borer, which is greatly to be feared in many localities. Where it is prevalent it is useless to plant locust. Another rapid-growing tree which is likely to prove of considerable commercial value when planted on fertile, fairly heavy, well-drained soils in the more northern portion of the State is the hardy catalpa. Excellent trees for windbreak and roadside planting are the European larch and black locust.

Except for the early planting in New England, the farmers of Ohio and Indiana have been the first to recognize the value and importance of forest planting. There are a number of rapid-growing broadleaf species adapted to this section which give early returns and which have been exploited by commercial nurserymen. In these two States and generally throughout the central valley district the practice has been to plant rapid-growing kinds. For example, in West Virginia and southwestern Pennsylvania, walnut, locust, sugar maple, red oak, chestnut, and catalpa have been planted for posts, mine props, and timber; in Ohio, black locust and catalpa for posts; in Indiana, black locust, catalpa, and walnut; in Kentucky, black locust, catalpa, tulip poplar, maple, and walnut, principally form mining timbers and posts; in Tennessee, locust, maple, and cedar; in Missouri, catalpa, locust, walnut, osage orange, cottonwood; in Arkansas, locust and walnut.

While black locust and hardy catalpa give excellent returns when planted under proper conditions, the most far-reaching and valuable result of the planting of these species has been to call attention to forestry and stimulate general interest in the growing of timber crops. Our present knowledge of conditions shows that without doubt the planting of other and more slow-growing species is fully justified from an economic standpoint. The state authorities of Indiana and Ohio are taking a leading part in promoting farm planting. Along the Ohio River in southern Indiana and Ohio there is much land now being farmed which would actually produce a higher return per acre if planted with black locust, or even with some of the slower-growing but more valuable hardwoods. Nowhere in the United States can there be found a more striking example of the need of timber belts for securing the highest results from agriculture even where there is scarcely an acre of waste land on any farm. Throughout this district every farmer should make provision for the future by renewing his woodlot, by planting where necessary, and should see to it that sufficient shelterbelts are planted to insure future protection to his homestead, his growing crops, and his orchards.

Southern Forest.—Of the total area of cut-over forest land which is not restocking naturally, about 70 per cent will reproduce pine if it is protected from fire. About 30 per cent, therefore, or more than 5,000,000 acres, will require artificial restocking. While most of this lies within the southern pine forest, there are limited opportunities for planting in the Appalachian Mountain region and in the northern portions of Georgia, Alabama, and Mississippi. Planting thus far has been almost altogether with rapid-growing hardwoods, such as catalpa, and for the most part has been ill-advised, and serves as no indication whatever of the lines along which planting should progress, since hardy catalpa is unsuited to this region. For quick returns of small-sized material, black locust is especially suited to the mountain and Piedmont sections of Georgia, and white oak is good for posts and ties, though for posts it will be best to grow loblolly pine and treat it with preservatives. Carolina poplar grows rapidly in the South and makes good chemical pulp; but since it has been found that pine can be used for pulp, the value of planting poplar is somewhat doubtful.

In general, however, planting is unnecessary throughout this region, because reproduction is abundant wherever there is protection from fire.

CENTRAL TREELESS REGION.

The central treeless region includes the States of Illinois, Iowa, North Dakota, South Dakota, Nebraska, and Kansas, the prairie district of Minnesota, and the portions of Oklahoma and Texas lying west of the hardwood belt. Forest planting has been a part of the progress in agriculture and therefore has been most extensive in the region of best agricultural development. Nebraska and Kansas lead in the acreage of plantations. About 840,000 acres have been planted within this central region, but there should be more than 14,000,000 acres.

As in the past, planting in this region will be almost entirely a private enterprise, carried on in connection with farming. While protection is, and in general will be, the primary object, planting should be done from the commercial standpoint, since by using only profitable species it will easily be possible to secure the double advantages of shelter and ornament, and at the same time to derive a revenue from all the plantations.

Until quite recently forest planting has declined or was at a standstill in the older farming regions of Illinois, Iowa, Nebraska, and Kansas, and the cutting of mature plantations offset the new planting that was being done. Shelterbelts are increasing in the newer farming districts of the Dakotas and Oklahoma, and, owing to their evident value to plantations, interest in planting is now being revived. This growth in interest is shown by figures from forty-five of the principal commercial nurseries which handle forest-tree seedlings. In 1906 they sent out 24,530,929 young trees; in 1907, 38,540,202; and in 1908, 40,791,193. Seventy per cent of these trees were hardwoods and 30 per cent conifers. The advantage and the necessity of having a certain proportion of the land in agricultural districts under forest cover have been clearly demonstrated; 5 per cent of the prairie region should be forested, and farther west on the plains 3 per cent may very well be devoted to tree growing.

The Forest Service of the Department of Agriculture is prepared to render practical assistance to farmers and tree planters, and since the opportunities have been foremost in the treeless States, the first efforts of the Forest Service were directed toward this region. There has been a wide distribution of literature in these States, and for several years Kansas and Nebraska have received more of the Forest Service literature than any other States. In Illinois planting is no longer being practiced so extensively as in the past. The total area planted by the farmers of this State is somewhat more than 15,000 acres, but the areas which might very properly be devoted to tree growing aggregate some 1,500,000 acres. The species chiefly used have been black walnut and hardy catalpa.

Probably 125,000 acres have been devoted to timber growing on the farms of Iowa. This is but a small fraction of the 2,000,000 acres which should be planted in order to keep the proper balance between cultivated land and woodland, and here again forest planting seems to be on the wane. Species which have been planted chiefly are, in the order of their predominance, silver maple, black walnut, cottonwood, boxelder, willow, ash, elm, and catalpa. In the western and southern prairie portions of Minnesota it is estimated that there are nearly 1,200,000 acres which should be planted. There have already been planted about 115,000 acres, and there is now a slight increase in the extent of planting. The species which are most commonly planted are boxelder, cottonwood, maple, willow, ash, and elm. In North Dakota more than 1,500,000 acres could very properly be planted with forest trees, in addition to the 52,000 acres which it is estimated have thus far been devoted to this purpose. It is interesting to note that in general throughout the entire State, which is a relatively new farming region, tree planting is rapidly on the increase, chiefly for shelter and for post production. The species mainly used are boxelder, cottonwood, green ash, and willow.

About 122,000 acres have thus far been planted in South Dakota, and at least 1,600,000 acres should be planted by farmers. As in North Dakota, the interest in tree planting is growing, and, in addition to the species which have been most popular in North Dakota, elm and soft maple have been used extensively in South Dakota.

Nebraska has an area of planted timber estimated to be 192,000 acres, and there are something more than 2,000,000 acres more which might be planted to advantage to utilize waste lands and provide adequate protection for crops in the farming districts. While Nebraska has deserved and won the name of "Tree Planting State," the indications are that planting is slightly declining, particularly in the eastern portion of the State. As in the other Western States, the chief purposes of past planting have been to secure shelter and to produce fuel and posts. Cottonwood, boxelder, ash, elm, and maple have been the species largely planted. Reliable data show that 175,000 acres have been planted with forest trees in Kansas, and at least 1,700,000 acres should be planted. In addition to the hardy species which have been most largely used in Nebraska, black locust, hardy catalpa, and black walnut have been favorites with the Kansas farmers.

In the prairie region of western Oklahoma over 21,000 acres have thus far been planted with trees. It remains for the landowners in this relatively new farming region to plant nearly 300,000 acres for the best interests of their section. The species chiefly used are black locust, hardy catalpa, maple, and cottonwood.

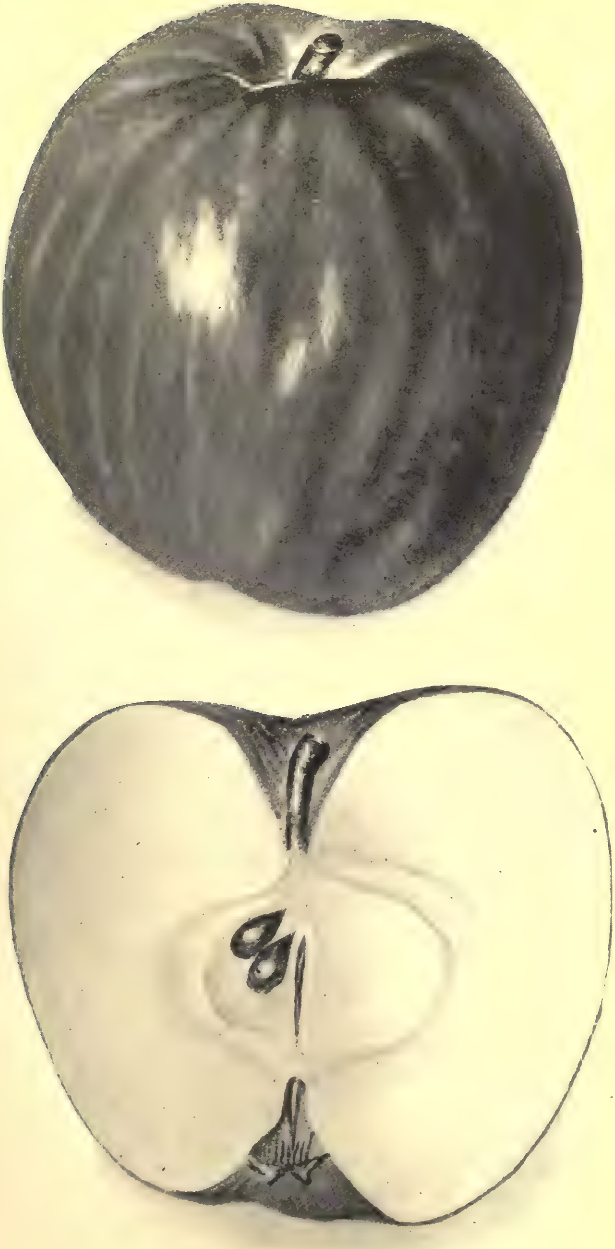
The planting of black locust, cottonwood, and catalpa is also being done on a rapidly increasing scale on the prairies and plains of the western half of Texas. Hardly more than 13,000 acres have, however, as yet been planted, and it will probably be many years before the ranchmen in this region will accomplish the planting of the 2,500,000 acres which should be devoted to tree growing.

As a whole, particularly for shelterbelts and windbreaks, the central region needs to use more conifers.

WESTERN REGION.

The western region includes the Rocky Mountain and the Pacific Coast States. Much of the forest land in the Western States is within National Forests, and forest planting on these lands is chiefly a federal problem. But there are abundant opportunities for private planting in the valleys of southern California and on irrigated lands throughout the region. It is essential that more than 2,500,000 acres of land in this region in private ownership should be artificially forested, and by far the greater portion of this planting must be done by farmers or ranchmen.

On irrigated lands the primary purpose of planting by private owners is identical with that in the central treeless region. Most of the irrigation projects are subject to strong winds, and protection



D. G. Passmore

WILLIAMS APPLE.

is essential. Forest planting by farmers in California is needed for the protection of watersheds, as shelterbelts for orchards, and for the production of commercial timber. The area of planted timber in this region is 38,862 acres, of which 37,100 acres have been planted by private landowners. A very interesting and economically valuable object lesson in planting is the aggregate of 20,000 acres of eucalypts in California. This presents a remarkable example of profitable returns from a quick-growing species, and shows the value of further experiments with exotic species in the United States. If proper species are used there should be no great difficulty in securing good shelterbelts and woodlots on western irrigated lands. Eastern trees have proved most useful in the limited planting done thus far. Ash, cottonwood, locust, elm, and introduced species, such as Norway spruce and Scotch pine, have been planted. The choice of species depends chiefly upon temperature, since moisture can be controlled by irrigation.

The development of planting in California has been more rapid than in any other State in the region. High returns from plantations have already been secured, and the southern part of the State is likely to be a great producer of eucalyptus (hardwood) timber for many uses, especially furniture and wagon stock. It is estimated that there are at least 1,000,000 acres of land in the valleys of southern California upon which continued irrigation for the production of fruit is not feasible, but which can be irrigated from time to time, and are well suited for the growing of eucalypts. The principal forest lands outside of National Forests lie in Washington and Oregon, west of the Cascades, and in California. Possibly 25 to 30 per cent of the cut-over lands in the former section will be devoted eventually to agriculture. Adequate fire protection and proper forest management will provide for a future timber supply on the remainder of these lands. Planting will be a small factor only, and supplemental to forest management, in order to restock areas that can not reseed naturally, because of lack of seed trees.—(Y. B. 1909.)

CANADA.

About one-third of the Dominion of Canada, 1,249,000 square miles, or nearly 800,000,000 acres, is classed as woodland, though the area stocked with commercial timber probably does not exceed 260,000,000 acres. The net exports of wood are over 2,000,000 tons a year—more than double those of the United States. The per capita consumption is high—60 cubic feet a year for timber and 132 cubic feet for fuel. A forest office in the department of the interior has been established since 1899, and since 1901 a protective service of fire rangers has been organized in some of the Dominion lands, with excellent results. Farmers and others, particularly in the central prairie regions, have been supplied free of charge with 7,000,000 seedlings for forest plantation.—(F. S. Cir. 140.)

Catalpa (*Speciosa*).—In making the catalpa a farm crop the risk is small because the product, in some form, will always be in demand, and there is a wide limit as to the time of harvesting. Much of the work can be done at a season of the year when farm work is not pressing and but little skilled labor is required. Intelligent oversight is necessary, however. The catalpa is adapted to a great variety of soils; is but little subject to the attacks of insects and fungi and resists decay when put in contact with the soil. The black or yellow locust has some of these qualities, likewise the osage orange and mulberry; but the Catalpa speciosa, or hardy catalpa, possesses more of them than any other tree. The catalpa is easily grown from seed and in some cases it may be advisable to grow the trees instead of buying them. If one knows how to distinguish the true speciosa and can find seed bearing trees of that species, it may be as well to take no risks of getting the wrong kind by buying trees. There are two very common species of catalpa which are found in nearly every neighborhood, both of which are undesirable. Both of these are more spreading and bushy than the speciosa. The filaments, or threads, at the ends of the seeds of these two forms of catalpa are drawn together, while those of the speciosa stand out parallel to each other like the hairs in a flat paint brush. The inferior kind seed very freely and the seeds are easily gathered, as they are nearer the ground, but the pods of the speciosa are more scattered and higher up. The seeds may be gathered at any time during the winter, but it is advisable to secure them as soon as the leaves fall in order to prevent loss by the opening of the pods. The seeds should be kept over winter in a dry, cool place. They are to be sown about the first of May, or as soon as the ground is in good condition.

A catalpa grove can not be cultivated in the same manner as a young orchard, as the growth is more rapid and the trees are closer together than fruit trees. In some cases cultivation may be impracticable, such as stony fields, newly cleared lands and steep hillsides.

On stony ground and steep hillsides the ideal method is to dig with a mattock a small space, about two feet square, where each tree is to stand, and then plant as advised in plowed ground. After planting success is more certain if each tree is mulched with straw, or some material which will keep the ground moist. Seeding with clover, if practicable is advantageous also. On ground which is newly cleared the same method of planting may be followed and clover seed sown, but the sprouts which start from the stumps of the trees which have been felled will need to be cut at least once during the season and may be thrown about the young trees to serve as a mulch.

It is seldom advisable to plant catalpa trees where either mulching or cultivation cannot be practiced. Some of the trees may grow and make good specimens without care, but the result will not be satisfactory where no attention is given them. All live stock, except chickens, should be kept from the catalpa grove for at least three years, but after that hogs might not injure the trees, although we know of no groves having been used in this manner. In case shade for live stock is the primary object and timber the secondary, the catalpa is as suitable as any tree.

Pruning is a matter of the utmost importance in growing catalpa trees. Much has been said regarding the necessity of securing forest conditions, *i. e.,* the shading of the soil by means of a thick growth, in order to prevent the loss of moisture; to discourage the growth of grass and weeds; to kill off side branches and to insure an upright growth of the trees. This plan has been sufficiently tested to show its impracticability. A catalpa grove is as much an artificial product as an apple orchard. Forest conditions in a catalpa plantation can be secured only at the expense of growth. Artificial conditions are more economical, at least at first, but later, natural conditions may be better.

A strawberry plant is often the worst weed in a strawberry bed and all surplus trees in a catalpa grove are weeds, or often worse than weeds. Trees can compete with grass and weeds far more successfully than with other trees, but competition of all kinds should be reduced to a minimum.

Cultivation does this for other crops and it serves the same purpose for the catalpa. If one would grow a catalpa grove successfully he must reduce the struggle for existence to the lowest limit by artificial means. Side branches are more economically removed by pruning than by close planting. An upright growth can be secured at less cost than by overcrowding of the trees. In close planting the original cost of the trees is several times greater than need be; the cost of thinning is considerable and the damage to the permanent trees is very great. Pruning is done for two purposes: (1) To secure a straight trunk or stem, (2) to secure a clean stem.

It often happens that a young catalpa tree will have two stems, or one crooked stem. In either case overcrowding would do no good, for trees of these classes are found no matter how closely they are planted. The only feasible plan is to cut such trees off close to the ground and let them start again. It is better to do this the latter part of the winter, or early spring, after the trees have made two seasons' growth in the grove. Preserve only one sprout and the growth will often be ten feet or more the first year.

It is the only way to insure trees with straight trunks and it has the further advantage of reducing the amount of pruning, because there are but few side branches on sprouts which spring from the stumps of trees that are cut back. The best time to do all pruning is late in winter or early in spring, although no harm will be done by cutting off very small side branches in early summer. The removal of much foliage in summer time, however, is harmful to the trees. Regarding the distance the trees should be apart in the permanent plantation, it is difficult to lay down a definite rule. Much depends upon the purpose for which the trees are intended, also upon the soil.

The cost of growing an acre of catalpa trees must vary according to local conditions; likewise the value of the crop will depend upon the soil and care given, so that an estimate as to the probable profits can be approximate only. An authority estimates the cost of growing an acre up to eight years to be $75 and by some the cost is put at a lower figure. The following estimate is from bulletin 108 of the Kansas Experiment Station: "Careful estimates based on the Yaggy forest give total cost of growing and marketing timber on one acre for ten years as $51.70; gross value of product in ten years, $267.15; net profit $215.45; net profit, less six per cent compound interest on expendtitures, $197.55 per acre; net annual profit for first ten years, $19.75; owner's estimate of present gross value of product (three years later than above valuation) $400 per acre; annual income of plantation at present as estimated by owner, $50 per acre."

The demand for catalpa timber is rapidly increasing. Railroads are in special need of tie timber. White oak, the best tie timber hitherto used is nearing exhaustion. The expense of chemically treating cheap ties of perishable wood is great. Metallic ties are out of the question on American road-beds. A strong demand exists for durable tie timber to replace oak. In 1900 there were 535,668,000 ties in track in the United States. Renewals in that year, 48,000,000, worth, at forty cents apiece, $19,200,000—nine per cent of the total in track. If laid with catalpa ties, annual renewals would not exceed four per cent, counting life of catalpa ties at but fifteen years; they have been known to last twenty years. Annual saving of expense of renewals thus affected, estimating the cost of catalpa ties also at forty cents apiece, $10,600,000.

The durable quality of catalpa renders it also especially valuable for fence-posts and for telephone and telegraph poles. Its value for post timber lies not only in its resistance to decay, but also in its not checking or splitting with age.—(Ohio E. S. B. 149; Kas. E. S. B. 108.)

THE BASKET WILLOW.

The growing of basket willows was introduced into the United States some sixty years ago by German immigrants who settled in New York and Pennsylvania. The industry was soon extended to Maryland and westward to Missouri and Iowa; it is now rapidly spreading over the nonarid regions of the far West. This industry, which has been languishing for a number of years, has recently taken a sudden leap and shows enormous possibilities. This is due entirely to improved methods of culture and to the introduction of new and choice varieties of basket willows. The cost of production in the United States has been greatly reduced, while the quality of the rods has been improved. These results have brought a betterment of the condition of both the grower and the manufacturer.

Great care should be taken in the selection of the soil and the location of the holt. Rich, permanently moist, sandy loam gives best returns, though ordinary moist sandy land often yields profitable crops of willows. Poor soils produce paying crops where there is a market for short rods. Avoid land on which water is stagnant during the summer. If by drainage the water level on such land can be lowered at least 6 feet below the surface, the situation may be considered appropriate. Do not plant willows in localities where early frosts occur. The tender shoots are easily injured by cold.

Plow 10 or 12 inches deep in the fall, prior to planting the following spring. This turns the top layer of the soil so deep that weed seeds can not spring up. If rain is insufficient, irrigate the holt, if possible, but thorough drainage must be provided, as water must not stand on the surface. It is best also to keep the land well drained during the winter.

Returns depend very largely upon the method of culture, but more upon the variety of willow planted. Willows with the most approved qualities should be planted, because the shoots of even the best varieties and in the most suitable soil grow brittle after the stools become old. The American green and Welsh willows are most generally planted. The rods of the former peel readily, split easily, are snow-white, hard, flexible, and heavy. They have a tendency to branch, however, and unless the stools are planted close together, a large percentage of the rods branch so much that they are often unfit for peeled stock. The Welsh willow yields less in bulk per acre than the American green, but surpasses the latter both in market value (because of better quality) and in specific weight. For planting along rivers to prevent erosion, Welsh willow is the best. The Lemley, or Caspian willow, is preferable for planting in poor, sandy land. In moist, rich, sandy loam it produces more than twice as much in weight as the Welsh willow. It is best to plant several varieties of willows in order to obtain a good crop of one or more each year, since all willows yield better crops some years than in others. A good basket willow possesses the following characteristics: (1) Ability to yield an annual and uniformly paying crop of rods; (2) Flexibility; (3) Productiveness, i. e., many shoots to each stool; (4) Slender and branchless rods; (5) Smooth and white wood after peeling.

Planting Willow Cuttings.—Cuttings for planting should be made from one-year-old shoots. The length of the slips is regulated by the condition of the soil. The richer the soil the shorter the cuttings may be. Generally they are made 8 inches long for moist, rich soil, and 12 inches for dry, sandy soil. Although it is generally advised to prepare cuttings just before planting, they may be made several weeks in advance and, partially buried in moderately moist sand, stored in a cold barn until needed. Bury the cuttings in sand to within 1 inch of the top. Care should be taken to have the buds point upward.

Plant early in the spring, as soon as the frost is out of the ground. In spacing the plants, the following principle holds for all willows and for all soils: The closer the cuttings are planted, the more valuable, i. e., more flexible, tough, slender, and branchless the rods become. On the other hand, they must not be planted so close that the soil in and between the rows can not be cultivated. As a general rule, cuttings should be spaced 9 inches apart in the rows and 20 inches between the rows. Willows with small leaves should be planted 6 by 18 inches or 5 by 15 inches apart. Otherwise they are likely to branch too much. The number of cuttings for an acre when the rows are 18 inches apart and the cuttings 6 inches apart is 58,080.

Cultivating the Holt.—The success of a plantation depends largely on sufficient soil moisture, freedom from weeds, and permanently loose soil. Cultivate early in the spring and as often as necessary to remove all weeds and to keep the soil loose. If this is done well for the first two or three years, there will be very little trouble with weeds thereafter, because the weeds are completely shaded out by the dense leaf development. Bind weeds and wild morning-glories are very troublesome in most holts, and must be removed. The holt can not be cultivated too often so long as the stools and shoots are not injured by the cultivator.

Harvesting the Rods.—The best time for cutting the rods is between November 15 and February 15. Rods from one-year-old holts should be cut at the end of the first year, preferably when the ground is frozen. During the first year the root system is small and care must be taken in cutting not to pull up the stools. Keep knife sharp and make the cutting strokes clean and decisive. Cut close to the stools—but not into them. Rods to be peeled are stood on end in a pit containing water from 4 to 6 inches deep and kept there until the sap rises (the buds open and leaves appear), when the bark can be removed. The peeled rods are quickly bleached and dried when exposed to the sun, after which they are sorted, tied in bundles, and stored in a dark dry place. Frequently willow rods are steamed or boiled in water for three or four hours as a means of preparing for peeling, a method which loosens the bark and renders the peeling easy. Boiling or steaming gives the rods an undesirable dark buff color which makes them less valuable. Rods are peeled by drawing them through a springy wooden or steel fork, shaped like a clothespin (fig. 10, 1-7), but larger. This loosens the bark in strands so that it can easily be removed by the hands.

Marketing Willows.—Peeled rods may be sold to local basket makers or to large willow-ware makers, who are usually glad to buy home-grown instead of imported stock. For the larger market the rods must be white and properly sorted according to sizes in order to compete with the imported stock, which is of good color and consists of long, straight, branchless rods, carefully sorted into equal lengths and into grades of uniform quality. Those who sell to local basket makers are able to offer them at a lower prices than those who have to ship to a distant market. The grower who sells to local consumers can also keep in constant touch with his customers and cater more successfully to their requirements in special varieties and grades of rods than can the grower whose product goes to larger markets.—(F. B. 341.)

EUCALYPTUS.

On the Pacific coast a natural hardwood supply is wanting. Oak and other hardwood lumber shipped in from the Eastern

States command such high prices as to make their use impracticable for most purposes. There is need of some hardwood that will grow rapidly and produce good lumber. Of the woods so far tried the eucalypts appear most likely to fill this need. True, they will not endure extreme cold, but experience indicates that in considerable portions of California and more restricted sections of New Mexico and Arizona conditions are well adapted to growing them. It has now been sufficiently tried in Florida also to justify planting it in localities where the temperature does not fall, for any long period, below 22° F., and with proper protection of the seedlings even where the temperature falls as low as 20° F. As a general rule, the commercial species of eucalypts may be introduced into any region in which citrus fruits and the olive will grow in the open. They apparently do best in a climate which permits of a distinct period of vegetative rest during the year, and are capable of withstanding temperature below freezing if the period of the low temperature is not long sustained and if it is coincident with the period of vegetative rest. The decisive factor is temperature—not the average temperature, but the absolute maximum and minimum temperatures—extremes in either of which are apt to prove fatal. Precipitation is of less importance, since the tree thrives in regions that have an average annual precipitation of less than 18 inches, and in regions in which the annual rainfall is more than 70 inches.

The benefits secured from windbreaks usually warrant their planting without special consideration of cost. Commercial plantations, however, should be established at the lowest possible cost, in order to secure the largest possible balance of profit when they are exploited. When plant material is purchased from dealers, the total cost of setting out plantations and of cultivating them for two years will average from $25 to $30 per acre. However, the cost of planting large areas with stock grown in a well-managed home nursery should not exceed $15 or $20 per acre. Careful management will reduce the planting cost, but it is poor economy to save at the expense of necessary care and cultivation. After the first two years the only cost of a plantation beyond the rental value of the land will be the cost of protection.

Returns may be had from blue gum plantations in from four to six years if they are cut for fuel wood. Merchantable saw timber may be produced in from twenty to thirty years. Under favorable conditions seedling groves yield, on the average, from 35 to 45 cords of fuel wood per acre in eight or nine years. Fuel wood should, however, be produced from sprout groves rather than from seedling groves, because sprout stands grow more rapidly. In five years they yield from 30 to 50 cords per acre, and in six years from 40 to 60 cords. The New England cord of 128 cubic feet is here referred to, but a short cord of 96 cubic feet is used in California, and to change the yield mentioned into California cords the amount should be increased one-third.

Fuel brings about $3 per cord on the stump. The average cost of cordwood manufacture is from $2 to $3, and the price of seasoned cordwood varies from $5 to $15 per cord in different markets. Fuelwood groves may be cut from two to four times at intervals of from four to eight years. After the first cutting the net returns from the tree crop will be greater, because an expenditure for planting and cultivation will not be required. Under average conditions seedling groves reach their maximum yield of fuel wood between the eighth and tenth years of growth, while sprout groves reach this period by the fifth or sixth year. The year when they should be cut is thus indicated. Blue gum seedling groves reach their maximum yield of saw timber between the thirtieth and fortieth years of growth. A yield of 32,000 feet board measure per acre is obtained in thirty years from seedling stands under average conditions. Lumber commands a price of from $100 to $125 per thousand feet in the limited market which it has found in California. Blue gum pile timbers bring from $5 to $15 apiece on the stump.

The wood of the eucalypts, unlike that of our northern-grown oaks and hickories, has no distinctive alternate bands of spring and summer wood. On this account the age of the trees can not be determined by counting the rings on a cross section of the stump. Bands of wood of different colors and densities can be distinguished on a cross section of eucalyptus, but they are often not continuous, and several may occur in a year's growth. The fibers of the wood are much interlaced, making it tough and more difficult to split for fuel than most woods. The grain is often irregular, which makes the wood liable to chip under the planer, but gives it a very pleasing effect when it is smoothly finished. When first felled, the eucalypts contain a large amount of water; often more than half the weight of the green wood is made up of water. Green eucalyptus logs sink immediately. This large amount of moisture and the irregular structure of the wood make eucalyptus lumber difficult to season properly. In color the wood of the eucalypts varies widely, shades of yellow, brown, and red predominating. In hardness and dry weight there is also a wide range.

Eucalyptus is sometimes used by farmers in California for wagon poles, shafts, axles, doubletrees, bolsters, spokes, hubs, felloes, and for the wooden parts of plows, harrows, and other agricultural implements, and, so far as known, it has given satisfaction. The results of the laboratory tests show that its strength is sufficient for vehicle construction. In addition to the possible economic value of eucalypts, several varieties have shown themselves to be valuable additions to our list of shade and ornamental trees. As ornamentals they are evergreen, which is a desirable feature in a region with little color, and possessed of a pleasing aroma. They have thus far been found free from fungus and insect pests, and unlike deciduous trees do not cast a litter of fallen leaves each year; although some of them shed considerable bark.—(F. S. B. 77; Ariz. E. S. B. 60; F. S. Cir. 179; F. S. Cir. 59; Calif. E. S. B. 196.)

ORNAMENTAL AND SHADE TREES.

The value to the farmer of ornamental and shade trees cannot be estimated in dollars and cents. Yet what farmer would be without his lawn shade trees on a hot summer's day when he is resting at the noon hour? What farmer will not pay more for a home that is supplied with shade and ornament? Such a home appeals to his esthetic sense in such a way that he considers it worth hundreds of dollars more. He knows too that it is worth more on the market.

BIRDS IN RELATION TO THE FARM.

The benefits the farmer derives from birds far outweigh the occasional damage they do. Notwithstanding this, as a rule, he is much more alive to the depredations of birds than to the benefits that accrue from them. Nor is this surprising, since the disastrous effects of a raid on sprouting corn by crows, or upon ripening cherries by robins and cedar birds, are too apparent to be overlooked, and the resulting loss can be estimated in dollars and cents. Not so the benefits. Occasionally, it is true, the effects of a combined attack of birds upon caterpillars, cankerworms, or other insects which are present in unusual numbers or have played havoc with the foliage, are too evident wholly to escape attention; but more often birds work unnoticed, and the good they do is not at once obvious to the busy farmer. There are few visible tokens of the process by which the crop of hay or green feed has been saved from the cutworms by crows, or the potato crop rescued from the Colorado beetle by the grosbeaks. The birds have done their work quietly but none the less effectively. They have saved, or greatly assisted in saving, the farmer's crop, and nobody is the wiser, save the few who make it the business of their lives to study the habits of birds. Few wild birds can exist without the forest or the woodlot upon which they depend largely for their homes, for water, and for sustenance.—(Y. B. 1907.)

ARBOR DAY.

It is eminently fitting that the "treeless" State of Nebraska should have the honor of originating the pleasant custom of Arbor Day. At the instance of the State Horticultural Society, about the year 1874, a day in the spring was set aside for tree planting. The feature met with such general support that the State Legislature, at its next session, took action favoring the annual observance of such a day. Over twelve thousand trees were planted in that State on its first Arbor Day. This happy beginning enlisted such general and widespread favor that other States soon followed with similar action. The peculiar fitness of the custom soon led to its adoption as a holiday feature of our public schools. The sentiments and emotions aroused on Arbor Day pass only too quickly; the important thing is that permanent results be left—lasting impressions in the minds of the children, and, flourishing in the earth, an object lesson in a tree plantation of use or beauty, or both combined.

The tree that is significant in the life of the Nation is, of course, the forest tree. Isolated trees, along the roadside, in the city streets, or in the school yard, please the eye and cool the air with their refreshing shade. But the forest of trees, where wood is growing to supply material for homes, for fuel, for a hundred industries; where the forest litter is storing the waters for streams to quench men's thirst, to irrigate their lands, to drive their mills, to fill their rivers deep for the vast traffic of inland navigation; in a word, the forest as producer and custodian of the necessaries of life and happiness, is the true message of Arbor Day.—(F. S. Cir. 96; Mich. E. S. B. 33.)

COMMERCIAL PRODUCTS OF THE FOREST.

A glance at the following data should at once convince the farmer of the financial benefit to be derived from the economic handling of his forest trees. The value of the forest products of the United States in 1907, the last year for which detailed data are available, was approximately $1,280,000,000. The principal items are shown below. The value in every case is stated in round numbers, and is estimated at the point of production.

Lumber, shingles, and lath	$ 750,000,000
Firewood	250,000,000
Poles, posts, and rails	100,000,000
Hewed cross-ties	60,000,000
Cooperage stock	35,000,000
Naval stores	30,000,000
Pulpwood	20,000,000
Tanbark and extracts	15,000,000
Round mine timbers	10,000,000
Miscellaneous	10,000,000
Total	$1,280,000,000

—(F. S. Cir. 166.)

Lumber.—The greatest output of the forest is that of lumber. It is usually made from large timber of high quality. Lumber is being made in commercial quantities from thirty different kinds of trees of which the softwoods furnish 77 per cent of the total yearly supply and the hardwoods 23 per cent.—(F. S. Cir. 171.)

Shingle Timber.—Shingles are made to some extent from a large number of woods, but the several varieties of cedar furnish nearly three-fourths of the total quantity. Some cedar shingles are made in the New England and northeastern states, and a considerable number in the Lake states, but a very large proportion of the cedar shingles are cut in Washington from the giant arborvitæ, the so-called "red cedar" of that region. Another species of the same genus is the arborvitæ or "white cedar" of the Lake states. Cypress is the next wood in importance in point of shingle production. The making of cypress shingles, however, is beginning to decrease. Manufacturers are finding it more profitable to work into other forms the material which formerly went into shingles. Yellow pine and white pine shingles have decreased still more heavily. The only important kinds of shingles which show any increase in production are cedar and red wood, and they are coming to occupy more and more a predominating position in the shingle-making industry. As is the case with the various kinds of lumber, the mill values of shingles have risen during the past few years.—(F. S. B. 77.)

Firewood.—The greater part of the firewood is obtained from farmers' woodlots which often have very little value for other purposes, especially when they have been neglected and the trees are knotty, or when fire has been allowed to run over the ground; but where good timber is plentiful, much that is suitable for lumber, cross-ties, cooperage, and similar purposes is cut for fuel. A little more than 20 billion cubic feet of wood in all forms is used in the United States each year, and of this 7 billion cubic feet, about a third, is firewood. The amount of wood consumed as fuel is exceeded only by that put into the form of lumber and shingles. Of the total estimated consumption of firewood, 70 million cords, or 81.4 per cent, was used on the farms; 12,615,000 cords, or 14.7 per cent in the towns and cities with a population of from 1,000 to 30,000; 1,615,000 cords, or 1.9 per cent, in cities of over 30,000 population; and the remainder, or 2 per cent, in mineral operations. In these four classes of consumption, the average value per cord ranged from $2.61 for the firewood used on the farms to $6.88 for that used in the cities. The value of commercial timber is now so great that as a matter of good husbandry in cutting his firewood the farmer will select those trees which have the least value as merchantable timber. He will also utilize the waste of the woodlot as firewood.—(F. S. Cir. 181.)

Pole Timber.—There are several qualities which timber must possess to adapt it to use for poles. The most important of these are: Durability in contact with the soil, minimum weight, straightness coupled with relatively small size, and little taper. The wood must be soft, so that the spikes of a climber may enter readily, and at the same time it must have strength to support considerable weight. These qualities are admirably combined in cedar and in juniper, which commercially is a cedar. No other woods possess so many.

Chestnut and cypress are both durable; chestnut is not so straight as cedar and is liable to be knotty. The wood, though soft, is not as soft as cedar. It has greater strength, but this advantage is more than counterbalanced by its greater weight, which prohibits long shipments. Cypress frequently is too large for use as a pole and has greater value for lumber. Even when its general diameter is small enough the butt will often be so big that it adds too much weight. Pine, besides being heavier than cedar, is less durable. Redwood possesses durability, lightness, and softness, but its size necessitates sawing, which adds to the cost.—(F. S. Bul. 77.)

Fence-Post Trees.—The best commercial fence-post trees to plant are the hardy catalpa, black locust, osage orange, Russian mulberry, Europe larch, and chestnut. To obtain the best commercial results none of these trees should be used outside of their economic planting range. Of the natural forests the oak and red cedar, even though more expensive than many others, are considered in many sections the most economic fence-post trees.—(F. S. Cir. 69.)

Cross-Tie Timber.—Oak, the chief wood used for ties, furnishes more than 44 per cent, nearly one-half of the whole number, while the southern pines, which rank second, contribute about one-sixth. Douglas fir and cedar, the next two, with approximately equal quantities, supply less than one-fifteenth apiece. Chestnut, cypress, western pine, tamarack, hemlock, and redwood are all of importance, but no one of them furnishes more than a small proportion. Oak and southern pine stand highest in both total and average value. Chestnut ranks next, followed by cedar. Hemlock is the cheapest. More than three-fourths of all ties are hewed; and with every wood from which ties are made, except Douglas fir and western pine, the number of hewed ties is greater than the number sawed. About ten times as many Douglas fir ties are sawed as are hewed. Of the oak ties a little over one-sixth and of the southern pine ties less than one-third are sawed. The market for ties is always active.—(F. S. B. 77.)

Cooperage Timber.—Staves are manufactured in considerable quantities from 14 different kinds of wood. The most important of these is elm, which furnishes more than one-fifth of the total number, with pine and red gum ranking next. These three kinds furnish practically one-half of the total number. Of the different kinds of staves, ash shows the highest average value. This is because the majority of ash staves are used for butter tubs and other packages which require wood that is sound and durable and at the same time is absolutely free from odor or taste that can be imparted to the contents. Elm has long stood pre-eminent in the manufacture of slack barrels, and has only recently been approached by other woods. Red oak makes an excellent stave. Red gum ranks next, while maple, beech and birch rank very close in value. Pine is the wood chiefly employed in the manufacture of heading, followed by elm, red gum, basswood, and beech. These different kinds of wood furnish nearly two-thirds of all the heading manufactured. Elm is the wood chiefly used for the manufacture of hoops, although a considerable quantity of ash, oak and birch is used. The large variety of woods used for slack cooperage is in striking contrast with the tight cooperage industry, in which one wood—white oak—furnishes nearly the whole amount.—(F. S. B. 77.)

Pulpwood.—The comparatively recent utilization of wood in the paper-making industry has been an important influence in the rapid advancement in the selling price of the farmer's wood supply. It is another reason why the farmer should handle his woodlot according to the best economic forestry methods. For the past twenty years wood, chiefly spruce and poplar, has furnished the greater part of the paper made in this country. In 1909, 4,002,000 cords of wood were used, yielding on an average 1,200 pounds of pulp per cord of wood, or a total of about 2,491,406 tons of pulp, which would make approximately 80 per cent of the paper and board annually produced in this country. The fibers of the soft coniferous woods are longer than those of the hard deciduous woods, the former being from 1 to 4 millimeters in length, while the latter are from 0.5 to 2.5 millimeters long. Spruce is more commonly used for making ground wood and pulp by the sulphite process, while poplar is almost exclusively reduced by the soda process. However, these woods may be treated by either process, depending on the cost of material, the location of the mill, etc.

Because of the exhaustion of the supplies of spruce and poplar within a reasonable distance of the mills, large quantities of other kinds of wood have been used for many years, not only for making board, bogus manila, and wrapping papers, but also for white papers, such as are used for news, book, and low-grade writing papers. Thus in 1909, 560,000 cords of hemlock, 91,000 of pine, 95,000 of balsam, 37,000 of cottonwood, 37,000 of white fir, 249,000 of slabs, and 183,000 cords of other kinds of wood were used for making paper, the larger part being chemically treated. Among the pines, white, gray, loblolly, and longleaf yellow pines are being used, while among the miscellaneous woods employed are red and white fir, larch, aspen, gum, cypress, beech, birch, maple, basswood, buckeye, and chestnut; other woods which are available in large quantities are being constantly experimented with at various mills. Indeed, practically all woods may be used for paper making, such use being governed chiefly by the character of the wood supply near the mill.

The reasons that have made wood the cheapest and preferred papermaking material are clearly evident. They are low cost of raw material; ease of transportation and handling, particularly by machinery; freedom from dirt; uniform supply, and low digester requirements, as much more wood can be placed in a given digester than any other material. Further than this, mills could be built and operated close to the material. But the spruce and poplar forests contiguous to many of these mills are gone and they can no longer obtain their wood at the old price nor at a price that will enable them to compete with mills more recently built, which are still close to a wood supply. Neither can such mills, built to use wood advantageously, use other materials in competition with mills especially built and equipped for using those materials. The demand developed in the past few years and constantly growing is not primarily so much for new materials as it is a demand for wood at a price that will enable the poorly situated mills to compete with those more economically located with respect to this supply. This demand can only be met either by a large use of other woods or by planting and growing spruce and poplar.—(F. S. Cir. 41.)

Tanbark and Tanning Extract.—The principal kinds of bark used in the tanning industry are hemlock and oak. Tanning extract to some extent is also made from chestnut and palmetto, the latter almost entirely from the roots. An extract which is made from both the bark and the wood of the chestnut tree is coming into use, being second only to the imported quebracha extract. The observing farmer may find a double market for his hemlock and oak timber, one for the wood and one for the bark.—(F. S. Bul. 77.)

Vehicle and Farm Implement Timber.—The uses of wood in the vehicle and implement industries may be considered under three heads: (1) For light vehicles: Buggies, carts, automobiles, spring wagons, etc. (2) For heavy vehicles: Farm wagons, drays, sleds, etc. (3) For implements: Grain tanks, thrashers, plows, harrows, cultivators, binders, headers, corn cutters, corn shredders, hay rakes, tedders, clover hullers, etc.

In buggy bodies the preferred woods for panel work are poplar and cottonwood and for framework ash. Many substitutes have been used because of the scarcity of poplar and ash. Red gum, basswood, silver maple, and buckeye are used to some extent for panels, and maple, oak, beech, red gum, rock elm, white elm, hackberry, butternut, and pecan are used in the framework. Of the new woods, maple and red gum are used to the greatest extent. Sheet iron has been tried for panels, but it holds paint so poorly and dents so easily that it is unsatisfactory. Red gum is much used for buggy bottoms and for all parts of sleighs. Rock elm has an elastic toughness coupled with a certain degree of hardness that has given it precedence in hub manufacture. These qualities allow the spokes to "settle" in the hub so that they form a close union without crushing the fibers. Black locust has this characteristic to a lesser degree, and persimmon, black birch, and dogwood are fairly satisfactory for hub manufacture. For buggy poles, shafts, spokes, and in the gear work, except for axle caps, for which maple has been largely substituted, hickory is practically the only wood used.

The following is a list of parts and the woods commonly used in the manufacture of heavy vehicles: Box boards—Yellow poplar, cottonwood, red gum, tupelo. Box cleats—Yellow poplar, cottonwood, rock elm. Box beds—Longleaf pine, birch, oak. Bed cleats—Oak, rock elm. Axles—Hickory, maple. Bolsters—Oak, hickory. Sand boards—Oak, hickory. Poles—Oak. Brake bars—Oak, rock elm. Reaches—Oak. Standards—Oak, rock elm, hickory. Hounds—Oak, rock elm. Spokes—Oak. Rims and fellies—Oak, Osage orange (southern trade). Hubs—White, red, and willow oak, black and yellow birch. Doubletrees—Hickory, rock elm, oak. Singletrees—Hickory, rock elm. Neckyokes—Hickory, rock elm.

A wood suitable for wagon-box boards is primarily one which does not warp nor split and is easily worked. The quality of resistance to abrasion is of importance, but durability is not considered. For box boards, white pine, when plentiful, was used almost exclusively; but yellow poplar is now the favorite, though cottonwood is largely used, and much of it is sold as poplar. Red gum, Douglas fir, cypress, western yellow pine, western spruce, and redwood have been used to a limited extent. These woods have answered the requirements fully where attention was given to overcoming small difficulties in handling. One objection to Douglas fir is that when passed through planers the softer and more spongy springwood portion of the annual rings is torn out, which leaves the summerwood portion raised, and gives the surface a ribbed appearance that increases the difficulty of getting a good finish. This disadvantage may be obviated, however, by increasing the speed of the planing machine and decreasing the feed.

The relative merits of maple and hickory for axle manufacture have been a matter of contention for years. Both woods are extensively employed, though maple finds greater use in the northern trade, while the southern trade prefers hickory. Endeavors to substitute steel for wood in axle construction have met with disfavor, since steel lacks the resilience of wood; the steel axle is described as "dead," the wood axle as "live." For bolsters, longleaf pine has been put upon the market as a substitute for oak, and has given satisfaction, though a coniferous wood as a rule will not hold the standards in place as well as a hardwood, because the fibers crush more easily.

White oak and white ash were used formerly for poles, but the increase in price of ash has led to the general use of oak, supplemented to some extent by Douglas fir and longleaf pine. In general the white and red oaks are now used indiscriminately and little choice is made between the two, except in special orders for select stock. The excessive checking, coupled with the high price of white oak, has led to the substitution of willow oak, red oak, and black and yellow birch for hubs. Birch hubs give the best results when they are shipped to the manufacturer in winter. Put into the warehouse while frozen, they can dry out gradually during cold weather, so that by the time they are sent to the dry house they are already comparatively dry, and molding has been prevented.

Implement manufacture permits the use of many kinds of wood. There are implements in which almost any kind of softwood can be used for panel work and any kind of hardwood for sill or frame work; so longleaf pine has, to a great extent, replaced oak in implement manufacture. Red gum and cottonwood are largely used for panels; the former is also used in combination with western spruce, pine, or fir, for narrow strip work, in places where it is liable to warp. In flaring grain tanks the side boards may be made of Douglas fir, western spruce, pine, red gum, or western hemlock, and the beds of longleaf pine, western hemlock, or Douglas fir. In these tanks it is possible to use a wood which has some tendency to warp, as the four or six knees which support the flaring sides hold them in place.

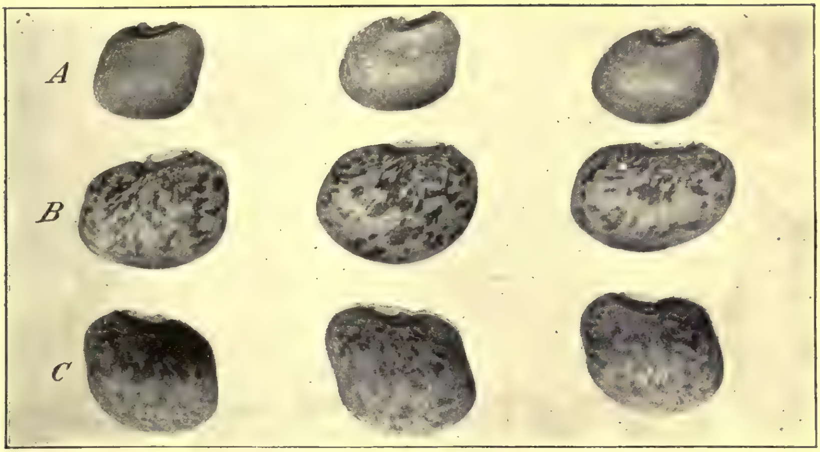
In wheat and corn drills and similar implements ash, maple, or oak is generally used for framework. Cottonwood, gum, poplar, Douglas fir, spruce, and western pine are used for panel work. Ash, rock elm, and oak are used for spokes and rims, in combination with a metal hub. For implement poles longleaf pine and Douglas fir have given most satisfaction. Throughout the vehicle and implement industries there is a marked and increasing tendency to use western coniferous woods.

Farm Carpentry Timber.—In carpentry we may distinguish between the covered or rough portions, such as the framework of a house, including sills, studdings, plates, joists, rafters, sheathing, and roof boards, and the exposed parts, such as the floors, doors, window frames, sash, blinds, and any stationary furniture, as store and office fixtures. For the former the wood must be abundant, in suitable, preferably standard, sizes, for any cutting involves extra labor and waste, any splicing adds to the cost and deducts from the value of the product. The wood for covered work should be straight, soft, or easily worked; it should be light, stiff, and insect proof, and should season rapidly without much warping. On the other hand it does not require to be tough or very strong, for if properly designed and used, the full strength of the frame of a house is never put to test; it need not be flexible, cleavable, nor handsome, and, so long as it is kept dry, but little provision is requisite for its durability. It is readily seen that the combination of properties here desired is possessed to a considerable degree by all our common coniferous woods; and as a matter of fact entire houses are built of pine, or spruce, or fir, and everything from a sill to a shingle is made of every one of the many conifers in the market, not even excluding the hemlock. Where choice exists, the heaviest forms furnish the stiffest lumber, and may therefore be used in the smallest dimensions. Nearly all this wood is nailed or spiked in place, very little is framed by mortise and tenon, and none is glued together.

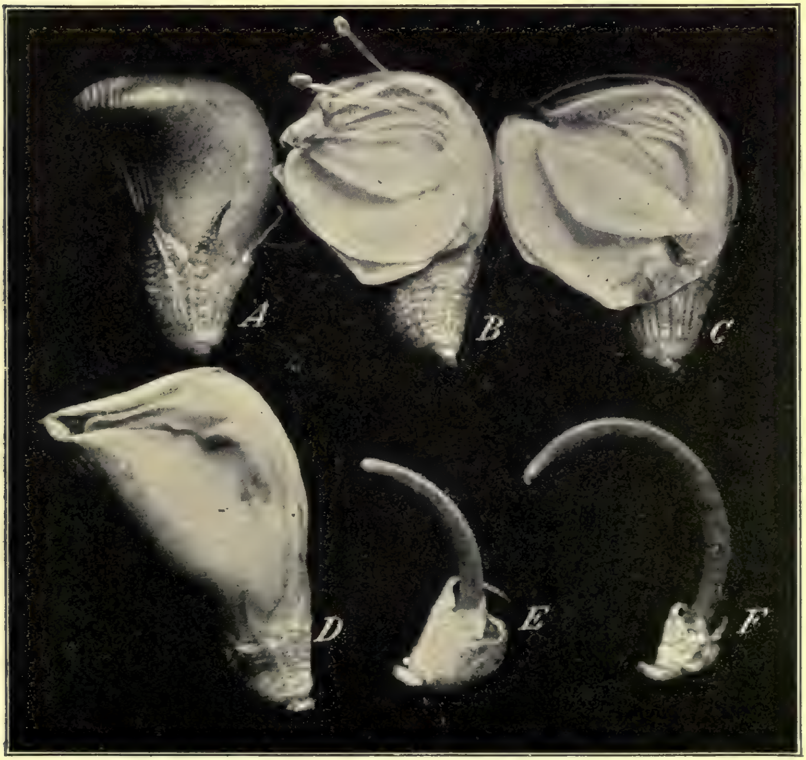
In selecting the lumber for the exposed portions of carpentry work great latitude exists. Aside from the floors, stairways, etc., where the hardness or resistance to wear establishes preference for hard woods, such as oak, maple, and birch, nearly the same qualities are demanded as for the covered work, with, however, the important addition of beauty, or satisfactory appearance, and a greater degree of hardness to protect against injury by denting and scratching. Though formerly a large part of this class of work was made of soft pine, the introduction of modern machinery, besides better taste and other causes, have greatly stimulated the use of hard pine and such hard woods as oak, ash, maple, birch, sycamore, gum, and elm, with a possibility of using almost every kind of wood grown in our forest. Generally, this finishing lumber, as it is commonly termed, is nailed to its place, the floors, ceiling, wainscot, etc., being tongued and grooved and thus in part framed together, while regular frame and panel work is used only for furniture, doors, and sash, and occasionally for ceilings and sides.—(Y. B.)

Paving Wood.—Round blocks, mostly of cedar, were extensively laid in the Middle West. They made neither a durable pavement nor in any way a satisfactory one. But they were cheap and served a good purpose in tiding fast-growing cities over a critical period. There have also been laid in various cities pavements of oak, cypress, white pine, hemlock, Washington red cedar, cottonwood, mesquite, Osage orange, redwood, Douglas fir, and tamarack. The longleaf pine is the species most used in the United States.—(F. S. Cir. 141.)

Veneer Timber.—Not all of the wood classed as veneer is actually used for veneering in the true sense, for with the development of veneering machinery a number of new uses have been found for wood in the form of veneer. Such of the softer woods as gum, cottonwood, and poplar are largely veneered for boxes,



Seeds of Cow Pea Parents and of a First Generation Cross. (*A*) New Era. (*B*) Whippoorwill. (*C*) New Era and Whippoorwill Cross. Dept. of Agr.



Flowers and Young Pods of the Cow Pea, Twice Natural Size. Dept. of Agr.

baskets, egg crates, and similar products. Such woods do not yield high grade veneers, but are used extensively for building up panels to be finished with a choice wood.

Woods which take a good finish and possess a pleasing grain or color, such as oak, maple, birch, or walnut, furnish the bulk of the true veneers; in fact, it may safely be assumed that practically all of the walnut and oak and a large percentage of the maple shown in this report are used in this way. Furniture and, to a limited extent, interior finishing, consume the most of these species. —(F. S. B. 74.)

Charcoal Timber.—The charring of wood is a process as old as civilization. In the early days the wood was charred under sod in the old charcoal kiln, which has been a familiar sight over a good part of the world. The modern charcoal kiln is so made that valuable vapors are condensed from the smoke, which in the old-fashioned kiln escaped into the air and was wasted. Kilns are now mainly used to produce charcoal for blast furnaces for pig iron. They are made of brick, with a circular base, and divided approximately into two semicircular sections. They hold each about 50 cords, and are charged and discharged by hand. The vapors are carried off into condensers, where the condensable ones are liquefied. —(F. S. Cir. 114.)

Pencil Wood.—A farmer who now owns a supply of red cedar either in the tree or in the form of posts and old rails is in a fair way to become wealthy. One of the most common articles in everyday use is the lead pencil. Something like 315,000,000 pencils are manufactured in the United States each year, and the industry is steadily growing. In the manufacture of these 315,000,000 pencils there are required 109,000 tons or 7,300,000 cubic feet of wood, so that each day in the year 300 tons or 20,000 cubic feet of wood are used for pencils. By far the greater part of this wood is red cedar. Its softness, straight grain, and freedom from defects render it peculiarly adapted to the purpose, and a suitable substitute has never been found. Indeed, it is doubtful if any other wood-using industry is so dependent upon a single species as the pencil industry is dependent upon red cedar.

To realize the scarcity of pencil material, it is only necessary to visit the cedar mill yards where are now being used old rails and small and knotty logs, which a few years ago would not have been considered. How long the supply will last is hard to say, but it is certain that some of the mills now in operation must shut down inside of a dozen years, and this regardless of any measures which may be taken in the meantime to protect the young growth.

The requirements for lead-pencil material are very exacting. A soft wood, even and straight grained, free from defects, and one which will not check or warp, is essential. The heartwood of red cedar fulfills these requirements and is, besides, very durable. The quality of the heartwood, however, varies widely throughout the tree's range. Even local conditions influence its texture. As an example of local variation, the heartwood of cedar which grows on hummocks and on low ground is decidedly of better quality than that of trees which grow on the upland. It has a more uniform dark red color, is softer, and contains very little white rot, or "pole-cat" wood, which occurs frequently in upland cedar. It is said by the pencil companies that the cedar found near its western range in Texas and Arkansas has a flinty texture, which gives it a poor grade and often relegates its use to penholders. Another defect, known as "bird's eye," often occurs in the cedars of both upland and hummocks. This blemish is a small black speck running from heart outward, and is really an old, dormant bud. Its effect on the quality of pencils depends on the size and frequency of the bird's eyes, but as a rule it does not seriously deteriorate the value of the wood.

While the heartwood of cedar is the material chiefly used for pencils, sapwood is often used for penholders. The demand for these, however, does not warrant the utilization of all the sapwood. It is therefore the practice of most mills to let the logs lie in the mill yard for several years, while the sapwood decays. This method allows the heartwood to mellow and season into better quality.

With the rigid demands of the pencil industry for clean heartwood, it is little wonder that the percentage of mill waste is unavoidably enormous. The waste varies with the quality and size of the timber. With the present timber the waste in cubic feet averages nearly 70 per cent, while in weight it is nearly 90 per cent. This refuse has little market other than for fuel, and most of it is given away.

Though the greater part of each year's output of red cedar is used for pencils, this is not by any means its only use. The exceptional physical qualities of the wood have caused its utilization for posts, poles, and ties, for which the poorer grades will serve, and for buckets, cigar boxes, and veneering, which, like pencils, require heartwood of the better grades. Yet the amount of cedar consumed in the manufacture of buckets, cigar boxes, and the like is comparatively small and is growing less as the supply of wood decreases. The pencil companies can afford to pay stumpage prices that are prohibitive to the other industries, and they thus furnish a ready market for all cedar of good quality. Pencil mills are scattered in every State where the source of supply promises to hold out longest with the least possible expense for transportation.

Two species of red cedar are used: The southern form, *Juniperus barbadensis,* and the northern form, *Juniperus virginiana.* The first is distinguished from the second by its more pendulous ultimate branchlets and its slightly smaller fruit, which contains on the average fewer seeds. These are practically the only points of difference, and in commercial use the two species are classed as one.

The commercial range of red cedar extends from the Ohio River on the north, as far east as eastern Tennessee and central Georgia, as far south as Tampa Bay on the west coast of Florida, and as far west as eastern Texas and western Arkansas. The tree almost invariably grows in mixture with hardwoods, and only in rare instances is it found in pure stands. In the Florida hummocks the chief associates of cedar are live oak, hickory, magnolia, red gum, and palmetto. Among these, cedar once grew to large size, but excessive cutting has taken out most of the large trees, leaving seedlings and saplings scattered beneath a dense cover of hardwoods and vines, where the young growth, notwithstanding its tolerance, has little chance for development. On the uplands farther north the principal associates are oaks, hickory, and elm. Only rarely is it found with pine. Among the hardwoods, cedar often forms from 50 to 60 per cent of the stand, and this proportion, under normal conditions, is increasing.

Distillation Wood.—The woods used are largely beech, birch, and maple, with the last preferred. The wood is cut into cordwood lengths and allowed to season for a year. According to the best information, the amount of the products obtained from green wood and from ordinary dry wood is not different, cord for cord, but the higher water content of green wood dilutes the distillate and necessitates more fuel for the carbonization. Excessive seasoning will doubtless reduce the yield of valuable constituents. Body wood is better than slab wood. Very small wood, such as thin edgings, carbonizes so rapidly that it must be mixed with larger pieces. The problem of the destructive distillation of sawdust has not yet been satisfactorily solved.—(F. S. Cir. 114.)

Dyewoods.—The most important trees sold in the United States for dyewood are the osage orange or hedge-tree, and the prickly ash. The osage orange is native to the rich bottom lands of southern Arkansas and westward to Oklahoma and Texas. It has been planted extensively throughout the eastern and central United States and is largely cultivated for hedges. By some it is claimed to be superior to fustic or true dyewood. The prickly ash ranges from southern Virginia to Florida and westward to Texas. The woods of the following species of semitropical Florida and the West Indies have appeared as substitutes for fustic or true-dyewood: Espino; yellowwood; satinwood; and wild lime.

Medicinal Barks.—The American trees and shrubs furnishing medicinal barks are the white pine, tamarack, aspen, white willow, bayberry, butternut, ironwood, sweet birch, tagalder, white oak, slippery elm, magnolia, tulip-poplar, sassafras, spicebush, witch-hazel, blackberry, American mountain-ash, wild cherry, prickly ash, wafer-ash black alder, wahoo, false bittersweet, horse-chestnut, cascara sagrada, dogwood, moosewood, white ash, fringe-tree, bittersweet, buttonbush, cramp-bark tree, and black haw.—(B. P. I. Bul. 139.)

Nuts.—Considerable activity has manifested itself in comparatively recent years relative to the commercial culture of chestnuts. The steady demand for the large nuts and the ready sale of these in competition with smaller sorts has stimulated their systematic culture, especially in the utilization of waste forest lands, as a supplementary crop for farmers. Chestnuts are found native in America from Maine on the North to Michigan and Tennessee on the West, and Louisiana and Georgia on the South. The hickory nut, under which general name is included the nuts of several species of native trees, of which the shagbark (*Hicoria ovata*) is the most important, is one of our best-known nuts. The quality of the hickory nut is exceedingly variable, both in flavor and the readiness with which the shell may be removed. The better varieties are highly esteemed, and by many are considered to compare favorably in delicacy of flavor with the English walnut. Large quantities of the nuts are eaten, and they are sometimes used in making cakes and confectionery. There is some confusion regarding the name of this nut. In some regions of New England it is known as the walnut, while the nut more generally known in the United States as the walnut, and which grows only sparingly in New England, is designated the black walnut. What is most generally known as the walnut in the United States (the fruit of *Juglans nigra* and closely allied species) is a large nut rich in oil and having a strongly marked flavor. This nut is somewhat used by confectioners.

The butternut, oil nut, or white walnut (*Juglans cinerea*) is extremely oily and has a tendency to become rancid. The fresh nut has an excellent flavor. It is less commonly marketed than some other native nuts. The beechnut is the fruit of a forest tree common in the eastern half of the United States. The nuts are sweet and of very agreeable flavor. Owing to their small size and the consequent difficulty of gathering them only a limited amount reaches the market.

The pecan (*Hicoria pecan*) is also a native of America, but is less widely distributed than the hickory, to which it is closely related. The flavor of the pecan makes it a desirable nut, but it doubtless owes much of its popularity to its thin shell and the ease with which the kernel may be removed. It is largely used as a dessert nut. Quantities are also used by confectioners for making salted pecans, bonbons of various sorts, etc.—(F. B. 114, 122.)

Maple Sugar and Sirup.—As a product of the forest maple sugar is of considerable importance to the individual farmer. Maple sugar making is possible only at a season when farm work is usually slack, and the time devoted to it may be virtually saved. As a matter of forestry it is therefore important that each individual farmer should know in a general way how to care for his maple trees. The ideal sugar grove should contain that number of trees which will give a maximum yield of sap per acre; whence it follows that the formation of a grove must consider the yield per given area rather than the yield per tree. To determine the exact number of trees that should occupy an area would take many years of experiment, but directly and indirectly there has been much information collected on the subject of sap production through a study of individual trees, and from this a number of safe deductions can be made. An equal amount of sunlight being given, the sap and sugar production is proportionate to the leaf area of the tree. This statement is corroborated in a bulletin of the Vermont Agricultural Experiment Station (103), where it is also asserted that the sugar production of the tree depends more on the actual leaf area than on the amount of light which it receives. In other words, if a smallcrowned mature tree be set free to light on all sides, the sap production will be stimulated only to a very slight extent. From this it follows that the number of trees per acre must be consistent with the greatest possible crown development of each tree in the grove. At the same time it is not to be forgotten that the maple is inherently a forest species. The large crown of foliage has an extensive leaf area for evaporation, and demands a protected soil which can keep it well supplied with water. Such soil is best found in the forest, where the ground is kept heavily matted with leaves and humus, so that the sun and drying winds will have little access to it, and a comparatively uniform degree of moisture and coolness may be maintained under all conditions. Commercial sugar making is confined to a small part of the botanical distribution of the sugar maple, because of a peculiar climatic requirement. It is the gradual northern spring, with the slow yielding of the frost by the ground, which makes the sap flow long and continuously enough to give a paying production of sugar. A sudden thaw affects both the quality and the duration of the sap flow. On this account it is always desirable to maintain forest conditions in a sugar grove, for if the ground has a heavy carpet of leaves and humus, it will be less sensitive to changes in temperature.—(F. B. 252.)

Turpentine.—The production of turpentine is an industry in which the farmer of the Southeastern pine regions is actively engaged. It is probable, however, that the injury from boxing to the growing trees overbalances in the long run the immediate pecuniary gain. It is one of the economic problems presented to the owner of the pine tree plantation.

Turpentine orcharding, as compared with lumbering, requires small capital and equipment. Transportation of crude turpentine is simple and inexpensive, and the work of orcharding is liked and well understood by the people. While the timber had as yet practically no stumpage value, turpentine stills went up everywhere, and forests entirely inaccessible for their timber could be profitably worked for turpentine.—(F. S. B. 43.)

Fur.—From the fur-bearing animals of the forest, especially where the timber is yet of dense growth, the farmer derives a considerable income at a time of the year when little else could be done. The preservation of species also depends upon the forest. Many farmers have found the raising of wild animals a profitable business. —(F. S. B. 36.)

Quality of Timber.—Sapwood is light and weak if from an old tree, but heavy and strong if from a young tree. Sapwood shrinks more and decays more easily than heartwood. A young tree makes heavier and stronger wood than an old tree, hence second growth is often better than old timber. The butt cut of hard pine weighs 20 per cent more and is 30 per cent stronger than the top cut. The heaviest stick of the same kind, when seasoned, is the strongest; a piece of seasoned pine weighing 45 pounds to the cubic foot is one-third to one-half stiffer and stronger than one weighing 30 pounds. Broad-ringed oak and pine, with broad, dark bands of summer wood, are strongest. Crossgrained and knots reduce both stiffness and strength. A crossgrained piece will scarcely support one-twentieth of the load that a straight-grained piece of the same kind will support.—(Y. B. 1895.)

Effects of Seasoning Timber.—A cord of green wood weighs 50 per cent more than when air dry. A cord of well-dried wood still contains 600 pounds of water. In the burning of green wood, nearly one-half the heat is lost in evaporating the water contained in it. One-half the weight of fresh, sappy pine is due to water. The kiln-drying of lumber, at a small expense, saves 1,000 to 1,500 pounds of freight per 1,000 feet, B. M. Seasoning increases stiffness and strength by about 50 per cent. Checks produced in drying decrease the value of timber; seasoning, therefore, always injures as well as benefits. Wood always swells and shrinks—that is, takes up and gives off water—hence the periodic recurrence of cracks in floors, etc. Split wood shrinks more evenly, sheds water and wears better than if sawed. Good hard pine shrinks about 6 inches per 100 inches width of flooring when laid green; good red oak about 9 inches. A "quarter-sawed" board shrinks only one-half to two-thirds as much as a bastard-sawed one. Wood shrinks inappreciably in length, 3 to 6 per cent in radial direction (across the rings), and 4 to 10 per cent in tangential direction (with the rings). Quarter-sawed boards and bastard-sawed boards neither shrink nor wear alike; hence for the best floors they should not be used side by side.—(Y. B. 1895.)

Stiffness and Strength of Timber.—Doubling the length of a board or timber reduces the stiffness eightfold and the strength one-half. Doubling the width of a board doubles the stiffness and strength. Doubling the thickness of a board or the depth of a timber increases the stiffness about eightfold and the strength fourfold. If, therefore, it is desired to double the length and retain the same stiffness, it is necessary to double the thickness or depth. Weight for weight, a stick of pine is stronger and stiffer than solid iron or steel of same shape and length. A joist 2 by 6 inches is three times as stiff as one 2 by 4. A joist 2 by 8 inches is eight times, and one 2 by 12 is twenty-seven times, as stiff. A good hard-pine joist 2 by 4 inches and 10 feet long may support 2,000 pounds in the middle, but it can safely be trusted only to the extent of 400 pounds. If weighted suddenly, a timber bends much more than if weighted gradually with the same weight. A timber projecting from the wall and weighted at the end (a cantilever) supports only as much as a timber twice the length resting on both ends and weighted in the middle.—(Y. B. 1895.)

FORESTRY ORGANIZATION.

This list is made up from the latest obtainable information.

Name of Organization.	*Address*
Appalachian Mountain Club	**Tremont Bldg., Boston.**
Arizona:	
Salt River Valley Water Users' Association	**Phoenix.**
California:	
Water and Forest Association	**1405 The Merchants Exchange Bldg., San Francisco.**

Forestry Educational Association	San Diego.
Sierra Club	San Francisco.
Pacific Coast Forest, Fish and Game Association	San Francisco.
Tri-counties Reforestation Committee	Riverside.
Colorado Forestry Association	Denver.
Connecticut Forestry Association	Elmwood.
Georgia Forest Association	Athens.
Indiana Forestry Association	Marion.
Iowa Park and Forestry Association	Des Moines.
Louisiana Forestry Association	254 Stoner Ave., Shreveport.
Maine Forestry Association	Augusta.
Massachusetts Forestry Association	4 Joy St., Boston.
Michigan Forestry Association	525 Bank Chambers, Detroit.
Minnesota Forestry Association	St. Anthony Park.
Nebraska Park and Forestry Association	York.
Society for the Protection of New Hampshire Forests	Concord, N. H.
New York:	
Forestry, Water Storage and Manufacturing Association of the State of New York	30 Broad St., New York.
Northern New York Forestry Association	Potsdam, N. Y.
New York State, Fish, Game and Forest League	Elmira.
The Association for the Protection of the Adirondacks	Tribune Bldg., New York City.
North Dakota State Sylvaton Society	Penn.
Ohio:	
Cincinnati Forest and Improvement Association	127 West Twelfth St., Cincinnati.
Ohio State Forestry Society	Wooster.
Oregon Conservation Association	904 Lewis Bldg., Portland.
Pennsylvania:	
Franklin Forestry Society	Chambersburg.
Pennsylvania Forestry Association	1012 Walnut St., Philadelphia.
Forestry Association of Vermont	Pittsford.
Washington Conservation Association	P. O. Box 236, Seattle.
West Virginia Forestry Association	Morgantown.

—(American Forestry, Aug., 1911.)

GRADUATE SCHOOLS OF FORESTRY.

Yale University, New Haven, Conn., Yale Forest School.

University of Michigan, Ann Arbor, course of forestry.

Harvard University, Cambridge, Mass., Division of Forestry, School of Applied Science.

UNDERGRADUATE SCHOOLS OF FORESTRY.

University of Minnesota, St. Anthony Park, College of Forestry.

University of Washington, Seattle, School of Forestry.

Colorado College, Colorado Springs, School of Forestry.

Colorado Agricultural College, Fort Collins.

University of Georgia, Athens, College of Agriculture, School of Forestry.

University of Idaho, Moscow.

Purdue University, Lafayette, Ind.

Iowa State College, Ames.

University of Maine, Orono.

Michigan Agricultural College, East Lansing, forestry course.

University of Montana, Missoula.

University of Nebraska, College of Agriculture, Lincoln.

Oregon Agricultural College, Corvallis.

Pennsylvania State College, State College.

State College of Washington, Pullman.

Biltmore Forest School, Biltmore, N. C. This school holds a winter session in Germany, a spring session in the Adirondacks and southern Appalachians, and a session during the autumn months in the Lake States.

Mont Alto Forest Academy, Mont Alto, Pa.

RANGER SCHOOLS.

A number of undergraduate schools of forestry have a short winter or summer course especially intended for the training of forest rangers. Several undergraduate schools, while not intended primarily for training rangers, give courses not much above the requirements of a ranger.

Alabama Polytechnic Institute, Auburn.
Connecticut Agricultural College, Storrs.
Delaware College, Newark.
Kansas State Agricultural College, Manhattan.
University of Illinois, Urbana.
Berea College, Berea, Ky.
Maryland Agricultural College, College Park.
Massachusetts Agricultural College, Amherst.
Mississippi Agricultural and Mechanical College, Agricultural College.
University of Missouri, Columbia.
University of Nevada, Reno.
New Hampshire College, Durham.
North Dakota Agricultural College, Fargo.
Oklahoma Agricultural and Mechanical College, Stillwater.
Rhode Island State College, Kingston.
Clemson Agricultural College, Clemson, S. C.
South Dakota State College of Agriculture and Mechanic Arts, Brookings.
University of Tennessee, Knoxville.
Agricultural College of Utah, Logan.
University of Vermont, Burlington.
Middlebury College, Middlebury, Vt.
Hampton Normal and Agricultural Institute, Hampton, Va.
West Virginia University, Morgantown.
University of Wisconsin, Madison.

COURSES IN SECONDARY SCHOOLS.

Eric Forest School, Duxbury, Mass.
Mount Hermon School, Mount Hermon, Mass.
Smith's Agricultural School, Northampton, Mass.
Crookston School of Agriculture, Crookston, Minn.
North Dakota School of Forestry, Bottineau.
Murray State School of Agriculture, Tishomingo, Okla.

—(F. S. Cir. 23, Fifth revision.)

INSTITUTIONS OFFERING INSTRUCTION IN FORESTRY.

Alabama—State Agricultural and Mechanical College, Auburn.

Arkansas—Arkansas Industrial University, Fayetteville.

California—University of Southern California, Los Angeles; University of California.

Colorado—The State Agricultural College of Colorado, Fort Collins.

Connecticut—Storrs Agricultural College, Storrs.

Georgia—Georgia State College of Agriculture and Mechanic Arts, Athens.

Idaho—College of Agriculture of the University of Idaho, Moscow.

Illinois—College of Agriculture of the University of Illinois, Urbana; English High and Manual Training School, Chicago.

Indiana—Purdue University, Lafayette.

Iowa—Iowa State College of Agriculture and Mechanic Arts, Ames.

Kansas—Kansas State Agricultural College, Manhattan.

Kentucky—Berea College, Berea; Ogden College, Bowling Green; probably also at the Agricultural and Mechanical College of Kentucky, Lexington.

Maine—The University of Maine, Orono.

Maryland—Maryland Agricultural College, College Park, only incidentally.

Massachusetts—Massachusetts Agricultural College, Amherst; Harvard University, Cambridge.

Michigan—Michigan Agricultural College, Agricultural College; State University, Ann Arbor; State Normal School, Ypsilanti.

Minnesota—College of Agriculture of the University of Minnesota, St. Anthony Park, St. Paul.

Mississippi—Mississippi Agricultural and Mechanical College, Agricultural College; touched on in botany.

Missouri—College of Agriculture and Mechanic Arts of the University of Missouri, Columbia.

Montana—The Montana College of Agriculture and the Mechanic Arts, Bozeman.

Nebraska—The Industrial College of the University of Nebraska, Lincoln.

Nevada—School of Agriculture of the Nevada State University, Reno.

New Hampshire—New Hampshire College of Agriculture and the Mechanic Arts, Durham.

North Carolina—The North Carolina College of Agriculture and Mechanic Arts, West Raleigh; North Carolina State University, Chapelhill.

North Dakota—North Dakota Agricultural College, Agricultural College.

Ohio—Ohio State University, Columbus.

Oklahoma—Oklahoma Agricultural and Mechanical College, Stillwater.

Oregon—Oregon State Agricultural College, Corvallis.

Pennsylvania—University of Pennsylvania, Philadelphia; The Pennsylvania State College, State College.

Rhode Island—Rhode Island College of Agriculture and Mechanic Arts, Kingston.

South Dakota—South Dakota Agricultural College, Brookings.

Tennessee—University of the South, Sewanee.

Texas—State Agricultural and Mechanical College of Texas, College Station.

Vermont—University of Vermont and State Agricultural College, Burlington.

Washington—Washington Agricultural College and School of Science, Pullman; University of Washington, Seattle.

West Virginia—West Virginia University, Morgantown.

Wisconsin—College of Agriculture of the University of Wisconsin, Madison.

Wyoming—College of Agriculture of the University of Wyoming, Laramie.

—(Y. B. 1900.)

References Consulted.—Roosevelt—F. S. Cir. 25; Chief Forester—Y. B. 1895; F. S. B. 44; Colo. Ex. Sta. B. 55; Y. B. 1894; Zavitz—Ont. A. C. B. 155; F. S. Cir. 145; F. B. 228; F. S. Cir. 54; F. S. Cir. 69; F. S. B. 17; F. B. 387; F. S. Cir. 140; F. S. Cir. 166; F. S. Cir. 171; F. S. B. 77; F. S. Cir. 181; F. S. Cir. 69; F. S. Cir. 41; F. S. Cir. 142; F. S. Cir. 141; F. S. B. 74; F. S. Cir. 114; F. S. Cir. 102; B. P. I. B. 139; F. B. 114; F. B. 122; F. B. 252; F. S. B. 43; B. S. B. 36; O. E. S. B. 149; Kas. E. S. B. 108; F. B. 341; F. S. B. 77; Ariz. E. S. B. 60; F. S. Cir. 179; F. S. Cir. 59; Calif. E. S. B. 196; Y. B. 1907; F. S. Cir. 96; Mich. E. S. B. 33; American Forestry, August, 1911; F. S. Cir. 23 (Fifth Revision); Y. B. 1903; Y. B. 1902; F. S. B. 7; Y. B. 1897; Y. B. 1904; Y. B. 1895; F. B. 173; F. B. 228; F. B. 358; N. Dak. E. S. B. 25; Mass. E. S. B. 97; Ohio E. S. B. 155; F. S. B. 42; Y. B. 1910; Y. B. 1900; Y. B. 1901; Y. B. 1896; Y. B. 1909; F. S. Cir. 41; F. S. B. 43; F. S. B. 92; Ohio E. S. B. 190; Vt. E. S. B. 139; N. H. E. S. B. 106; F. S. Cir. 81; Ohio E. S. B. 155; Ohio E. S. B. 110; Ohio E. S. B. 189; F. B. 67; F. S. B. 27; F. S. Cir. 37; F. S. Cir. 99; F. S. Cir. 109; Okla. E. S. B. 60; Okla. E. S. B. 73; F. S. B. 93; N. Dak. E. S. B. 59; Minn. E. S. B. 72; F. S. B. 65; S. Dak. E. S. B. 53; Iowa E. S. B. 90; Tex. E. S. B. 105; F. Cir. 154; Kas. E. S. B. 120; F. S. B. 18; F. S. B. 52; F. S. B. 66; F. S. B. 86; Okla. E. S. B. 60; Kas. E. S. B. 108; Ohio E. S. B. 158; Y. B. 1905; F. S. Cir. 39; F. S. Cir. 186; F. S. B. 78; F. S. B. 35; F. S. B. 37; F. S. B. 40; F. S. B. 46; F. S. B. 74; F. S. B. 75; F. S. B. 99; O. E. S. B. 219.

CLASSIFICATIONS OF THE MOST IMPORTANT FOREST TREES.

The following list contains 100 species, selected from the 450 species of trees of the United States, which may be considered of highest value.

The relative value of the different species here enumerated is indicated in three classes by difference in type, as follows: First grade, **WHITE PINE**; second grade, JEFFREY PINE; third grade, *PITCH PINE.*

The size stated refers to averages of mature trees; the + sign denoting that larger dimensions are not uncommon.

A. CONIFERS.

(Evergreens and needle-leafed trees, with a few exceptions.)

The most valuable forest trees, as well on account of their usefulness as for their effects in forestry, due to the evergreen foliage of most of them persistent through several years; most capable of covering extensive areas exclusively, and with deciduous trees most excellent aids in forestry on account of their habit of growth and their soil-improving qualities; practically not capable of reproduction by sprouting from the stocks or cuttings; mostly periodical seeders; persistent growers.

PINES.—The most useful conifers and most important forest trees, mostly of the plain; reaching desirable development in comparatively dry, even barren situations. Mostly needing light; tolerably rapid growers; best on light sandy soils with clay subsoil.

Characteristics.—Leaves arranged in twos, threes, or fives in one sheath; cones with thickened scales; seeds almond-shaped, nut-like, of mottled appearance, with their wings only lightly attached; maturing the second year, and preserving their germinating power well. Sixty to seventy species, of which thirty-five are indigenous to the United States.

Wood.—Very variable, very light and soft in "soft" pine, such as white pine; of medium weight to heavy and quite hard in "hard" pine, of which Longleaf or Georgia pine is the extreme form. Usually it is stiff, quite strong, of even texture, and more or less resinous. The sapwood is yellowish-white; the heartwood, orange-brown. Pine shrinks moderately, seasons rapidly and without much injury; it works easily; is never too hard to nail (unlike oak or hickory); it is mostly quite durable, and if well seasoned is not subject to the attacks of boring insects. The heavier the wood, the darker, stronger, and harder it is, and the more it shrinks and checks. Pine is used more extensively than any other kind of wood. It is the principal wood in common carpentry, as well as in all heavy constructions, bridges, trestles, etc. It is also used in almost every other wood industry, for spars, masts, planks, and timbers in shipbuilding, in car and wagon construction, in cooperage, for crates and boxes, in furniture work, for toys and patterns, railway ties, water pipes, excelsior, etc. Pines are usually large trees with few branches, the straight, cylindrical, useful stem forming by far the greatest part of the tree; they occur in vast forests, a fact which greatly facilitates their utilization.

List of One Hundred Species of Trees of the United States Most Valuable for Timber, with Notes on Their Range of Distribution, Cultural Requirements, and the Character and Uses of Their Wood.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
1. **WHITE PINE**........ (*Pinus strobus* Linn.)	Northern; wide range, forming forests to Southern mountains.	Light, soft, not strong, heartwood durable in contact with the soil; *free from resin and easily worked.*	Best on light, sandy, fresh, deep soils, but successful on a large range of soils from dry to moist. Rapid grower; endures some shade; hardy, but little tolerant of drought.

WHITE PINE—Continued Height, 120 feet +; diameter, 3 feet +.	Best development in region of the Great Lakes.	Immense quantities used for *lumber* of different kinds, cabinet work, timber, shingles, laths, and inferior fuel.	The *most important* conifer of the United States; good quality, however, only in centenarians. Is best mixed with deciduous trees; of rather slow, but high percentage of germination; plant one or two-year old transplanted seedlings, or sow.
2. RED PINE............ (NORWAY PINE.) (*Pinus resinosa* Ait.) Height, 100 feet +; diameter, 2½ feet +.	Northern; associated mostly with White Pine. Greatest development from Michigan to Minnesota.	Light, harder and stronger than that of White Pine; elastic, very resinous; wide sapwood; hence young timbers, piles, etc.; not durable. Used chiefly for *lumber*, timber, and piles; in the trade, handled together with White Pine.	Soils like those of White Pine; adapted to many soils, but best quality of timber produced in well-drained sands. Extremely hardy; *vigorous* and *rapid* grower. Should be favored in northern and northeastern planting with White Pine and deciduous trees. So far, seed very expensive and difficult to obtain.
3. *PITCH PINE*........... (*Pinus rigida* Miller.) Height, 50 feet +; diameter, 1½ feet +.	Northeastern and Middle Atlantic States.	Light, brittle, harder, and stronger than that of White Pine. Employed chiefly for fuel and charcoal, but occasionally for inferior lumber and mine props.	Best on fresh to moist sand, but will succeed on dry, barren, sandy, or rocky soils, and even on wet, cold, swampy ground, or seacoasts liable to floods. A rapid grower, and when young, hardy and indifferent to drought; light-needing; an early seeder; sprouts from the stump; not easily transplanted; best and *easily* propagated from *seed;* mainly for *seacoast* planting.
4. *JACK PINE*........... (SCRUB PINE. PRINCE'S PINE.) (*Pinus divaricata* (Ait.) Gord.) Height, 60 feet +; diameter, 1 foot +.	Northern (in United States), forming forests far north. Greatest development north of Lake Superior.	Among the lighter "hard pines." Employed chiefly for fuel and ties.	Common on sandy, barren soil. Valuable only as first cover for northern pine-barrens. Rapid grower in its youth and easily handled; very hardy, enduring heat and cold well; successful on the plains.
5. *SCRUB PINE* .... (*Pinus virginiana Mill.*) Height, 80 feet +; diameter, 2 feet +.	Middle Atlantic region.	Extensively used for fuel; pump logs, water pipes, occasionally for piles and coarse lumber.	Common on poor, dry, sandy, gravelly, and clayey soils; less frequent in rich soils. Moderately rapid grower, quickly taking possession of old, worn-out fields and washed lands.
6. LONGLEAF PINE..... (SOUTHERN PINE. YELLOW PINE. GEORGIA PINE. HARD PINE.) (*Pinus palustris* Miller.) Height, 100 feet +; diameter, 2½ feet +.	South Atlantic and Gulf States.	Heavy, hard, tough, and very strong; *very durable, very resinous.* Chiefly for *lumber;* shipbuilding, fencing, ties; good fuel. The *turpentine*, tar, pitch, and spirits of turpentine of United States market are derived almost entirely from this tree.	Well-drained, loose, deep sandy loam or gravel. The slow growth of first five years (quasi-endogenous) makes its forestry problematic; development dependent on atmospheric moisture; least shade-enduring of pines. Rare but plentiful seeder; germinates freely; can therefore be propagated by sowing seed in permanent place. Most valuable pine of the South, but for best quality requires long period of growth (two hundred years?).

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
7. **SHORTLEAF PINE**... (Bull Pine. Yellow Pine. Spruce Pine.) (*Pinus echinata* Miller.) Height, 90 feet +; diameter, 2 feet +.	Middle Atlantic and Southern States; associated mostly with hardwood trees. Best development in western Louisiana, southern Arkansas and eastern Texas.	Medium "hard pine" .... Used chiefly for furniture *lumber*. Very much like that of Longleaf Pine, but somewhat inferior; in some localities bled for turpentine.	More common on light sandy soil than on low borders of swamps. A rather slow grower; will succeed on the poorest soil. Easily reproduced; good seeder; light-needing.
8. **CUBAN PINE**........ (Slash Pine. Swamp Pine. Bastard Pine.) (*Pinus heterophylla* (Ell. Sudw.) Height, 90 feet +; diameter, 2 feet +.	Southern and southeastern coast; local in swamps and near water courses. Best development in eastern Florida.	Heaviest and strongest of our hard pines; not distinguished in the market from Longleaf Pine. Employed for construction, timber, and lumber; yields resinous matter; equal to Longleaf Pine.	Light sandy soil; somewhat indifferent to drainage. *Rapid grower; easily reproduced;* matures seed yearly; competing with the Longleaf Pine on wet sags; light-needing.
9. **LOBLOLLY PINE**..... (Old-field Pine.) (*Pinus tæda* Linn.) Height, 100 feet +; diameter, 2½ feet +.	Southeastern .... Greatest development in Virginia and North Carolina.	Wood typical "hard pine"; mostly coarse-grained; wide sap; very variable in quality. Used principally for lumber of an inferior quality and for fuel; yields very little *resin*.	Low, moist, or dry sandy soils and abandoned fields. Adapted to a wide range of sites. Rapid grower; *light-needing;* seeds persistently and plentifully. A useful concomitant of Southern forestry.
10. ***SPRUCE PINE***........ (Old-field Pine of Florida. Cedar Pine. White Pine. (*Pinus glabra* Walter.) Height, 80 feet +; diameter, 2 feet +.	Southeastern States ..... Best development in Alabama and Mississippi.	Light, *soft, easily worked,* brittle, not strong nor durable; resembles that of *Pinus tæda;* not resinous, coarse-grained, wide sap. Rarely cut; for inside work not distinguished in the market from Loblolly and Shortleaf Pine lumber.	Grows on better and moister soils than *Pinus tæda*, Loblolly Pine hummocks and rich bottom lands; rare; usually isolated or in groups. A rapid grower; shade-enduring.
11. **BULL PINE**.......... (Yellow Pine. Heavy wooded Pine. (*Pinus ponderosa* Douglas.) Height, 200 feet +; diameter, 12 feet +.	Rocky Mountains to the Pacific, up to high elevations; forming forests. Best developed on western slope of Sierras of northern and central California.	Very variable in quality, brittle, strong; not durable. Employed largely for lumber, mining timber, ties, and fuel.	Dry, rocky ridges and prairies, sometimes in swamps, but best in deep loamy sand. Vigorous, rapid grower; very hardy, except when quite young. Well adapted to dry, windy, exposed places; succeeds on Western prairies. The pine for reforesting southern exposures of the Western mountain regions.

12. **JEFFREY PINE**...... (BULL PINE.) (*Pinus jeffreyi* Murray.) Height, 100 feet +; diameter, 4 feet +.	California and Oregon; western slopes of Sierra Nevada above 6,000 feet.	Quality and uses like Bull Pine....	Replacing Bull Pine; rare.
13. ***BRISTLE-CONE PINE.*** (*Pinus aristata* Engelm.) Height, 100 feet; diameter, 4 feet.	Local—Rocky Mountains and southeastern California; above 7,500 feet.	Light, soft, not strong............ In Nevada employed for mining-timber.	Dry, gravelly ridges. The White Pine for cover of high elevations in southern Rocky Mountains.
14. **SUGAR PINE**......... (*Pinus lambertiana* Dougl.) Height, 150 feet +; diameter, 4 feet +.	Western Pacific slope..... Best development in Sierras of central and northern California above 4,000 feet; lower in Oregon.	Typical "soft pine," like the White Pine of eastern United States, and used similarly. Seeds large and edible.	Very rapid grower. Quite hardy in the East. Best Pine for reforestation in its native habitat.
15. ***MONTEREY PINE***.... (*Pinus radiata* Don.) Height, 80 feet +; diameter, 2 feet +.	Local—California coast, south of San Francisco.	Light, soft, brittle, not strong; according to some authorities, tough and of good repute.	Light, well-drained soils, and on drifting sands. Easily propagated; seed of very high percentage of germination; very rapid grower. Useful for reforesting Western barrens.

II. SPRUCES.—Next in importance to the pines, though the wood is less resinous, weaker, and not so durable. Of northern or mountain habitat, in cool situations and moist soils; endures shade and grows mostly with rapidity and persistency. The Norway Spruce of Europe appears, so far, superior for forestry to the native species.

Characteristics.—Leaves single, rigid, sharp-pointed, four-cornered, bristling mostly all around the twigs; cones oblong, hanging, with thin, persistent scales; seeds resembling those of the pines, but usually smaller, more uniform in color, and angular; mature the first year, and preserve power of germination well; mostly periodical, but seeds abundantly; crown pyramidal; about twelve species, of which five are indigenous. Spruce wood resembles soft pine, is light, soft, stiff, moderately strong, less resinous than pine; has no distinct heartwood, and is of whitish color; used like soft pine, but also employed as resonance wood, and preferred for paper pulp. Spruces, like pines, form extensive forests. They are more frugal, thrive on thinner soils, and bear more shade, but usually require a more humid climate. ''Black'' and ''white'' spruce, as applied by lumbermen, usually refer to narrow and wide ringed forms of the Black Spruce (*Picea mariana.*)

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
16. BLACK SPRUCE.....	Mainly northeastern; forming forests.	Light, soft, strong................	Light, dry, stony soils; much smaller in cold, wet swamps.
(*Picea mariana* Mill.) B. S. P. Height, 80 feet; diameter, 1½ feet +.	Best development north of latitude 50°.	Used most largely for pulp, also for lumber, shipbuilding, posts, piles, poles, ties; *tougher, stronger,* and more *elastic* than that of white pine; not good fuel.	Endures less shade than Norway Spruce; rapid grower.
17. WHITE SPRUCE..... (*Picea canadensis* Mill.) B. S. P. Height, 100 feet; diameter, 1½ feet +.	Mainly northeastern and extending into Rocky Mountains; forming forests.	Like the Black Spruce, from which the timber is not distinguished in commerce, and used for the same purposes.	Like Black Spruce, but probably better adapted to western planting, being hardier.
18. ENGELMANN SPRUCE	Western mountain regions and northward; high elevation.	Very light, soft, not strong.......	Dry, gravelly slopes, 5,000 to 11,500 feet.
(WHITE SPRUCE.)		Resembles the wood of eastern spruces in quality and uses.	A tree for reforestation of mountain slopes along water courses.
(*Picea engelmanni* Engelm.) Height, 100 feet +; diameter, 3 feet +.	Best development in central Rocky Mountain region, between 9,000 and 10,000 feet.	Used chiefly for lumber; bark used in tanning. (?)	
19. SITKA SPRUCE..... (TIDE-LAND SPRUCE.)	Alaska and Northwestern coast; low elevations.	Light, soft, not strong (according to others strong); superior to that of other native species, but almost always coarse-grained.	Moist soil and climate, at least a moist subsoil, shady situations. *Rapid grower.* Probably hardy in Northeastern and Middle States, in shaded positions.
(*Picea sitchensis* Carrière.) Height, 150 feet +; diameter, 6 feet +.		Used chiefly as lumber for construction, interior finish, fencing, boatbuilding; cooperage, woodenware, boxes.	

III. **Firs.**—Important to forestry mainly on account of their great endurance of shade. Of northern and mountain distribution; still more dependent on moisture of climate and cool or at least evenly tempered situations than the spruces, and in their youth mostly less hardy; usually grow slowly, but persistently. Some exotics seem to be of more value than the native species. (*Abies nordmanniana.*)

Characteristics.—Leaves single, flat, rather blunt, arranged somewhat comb-like on the twigs. Cones cylindrical, standing erect on the branches; scales thin, and falling away when mature; seeds triangular, partly inclosed by a more or less persistent wing; mature first year, but do not preserve their power of germination well. Frequent and abundant seeders. Crown conical. About eighteen species, of which eight are indigenous.

The name is frequently applied to wood and to trees which are not fir; most commonly to spruce, but also, especially in English markets, to pine. The wood resembles spruce in color, quality, and uses, but is easily distinguished from it, as well as from pine and larch, by the absence of resin ducts.

List of One Hundred Species of Trees of the United States Most Valuable for Timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
20. WHITE FIR......... (BALSAM FIR. BLACK BALSAM.) (*Abies concolor* (Gord.) Parry.) Height, 100 feet +; diameter, 4 feet +.	Southwestern mountains and Pacific slope; high elevations. Best development in Sierras of California.	Very light, soft, not strong........ Occasionally manufactured into lumber, butter tubs, and used for other domestic purposes.	Moist slopes and canyons, between 3,000 and 9,000 feet; cool and shady situations.
21. *BALSAM FIR*........ (BALM OF GILEAD FIR.) (*Abies balsamea* Miller.) Height, 70 feet +; diameter, 1½ feet +.	Northeastern States and northward.	Very light, soft; not strong nor durable in contact with the soil. Used for common lumber (boxboards) and pulp wood.	Cold, damp woods and swamps. Rapid grower. Valuable only as undergrowth, or as nurse, and in imperfectly drained situations.
22. GREAT SILVER FIR. (WHITE FIR.) (*Abies grandis* Lindl.) Height, 200 feet; diameter, 5 feet +.	Northwestern coast...... Best development in western Washington and Oregon, along river bottoms.	Light, soft, not strong............ For lumber, cooperage, etc........	Bottom lands; rich moist soil. Very hardy and rapid grower; affected less by late frosts and occasional droughts than most firs.

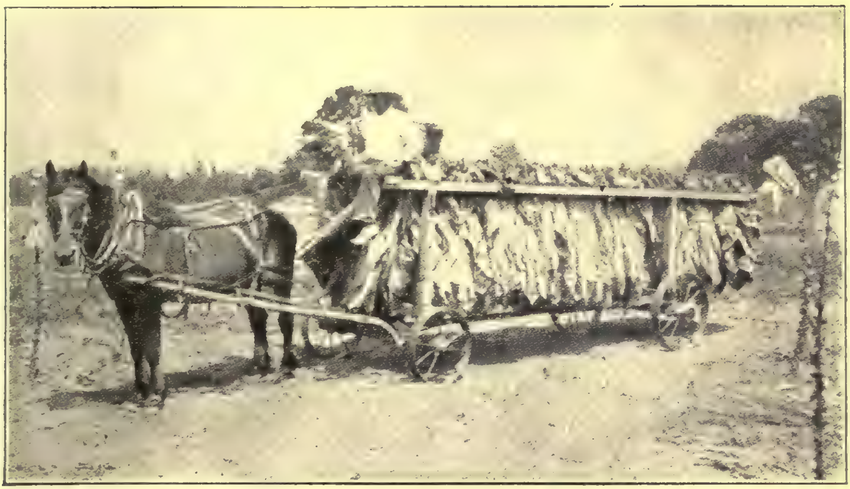
Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, characteristics of growth.
23. NOBLE FIR.........	Northwestern coast; wide range; always near mountain tops and high elevations; found often in groves dispersed through extensive forests.	Light, hard, elastic, and tolerably strong.	Probably hardy east of the Rocky Mountains, with proper protection.
(*Abies nobilis* Lindl.) Height, 200 feet +; diameter, 5 feet +.	Best development in Sierra Nevada, from Columbia River to northern California.	Excellent lumber for interior finish. Sold in market as "larch."	Requiring moist atmosphere for best development.
24. AMABILIS FIR......	Northwestern coast, mostly associated with the preceding species.	....	Gravelly soils.
(*Abies amabilis* (Loud.) Forbes.)			Will probably prove hardy in Eastern States.
Height, 100 feet +; diameter, 3 feet +. According to others, 250 feet high and 5 feet in diameter.	Best development on mountains south of Columbia River; 3,000 to 4,000 feet.	Like Noble Fir, with which it is cut and marketed.	

IV. Bastard Spruces.—Under this name may be grouped the Hemlocks and Douglas Spruce, formerly classed with the spruces and firs proper. Mostly of northern distribution, and therefore best adapted to cool, moist situations; enduring considerable shade. Some of the species grow very rapidly.

Characteristics.—Leaves single flat, linear, with distinct stalks (petioles) somewhat comb-like in their arrangement on the twigs. Cones usually small, with thin scales, hanging from the ends of the branches. Seeds, partly inclosed in a persistent wing; resemble those of the firs, but of smaller size; mature the first year, do not keep well; low percentage of germination. Branches pendant; crown spindle-like in form. Two genera, comprising seven species, five of which are indigenous.

The wood of the Douglas Spruce resembles the common ''hard pine'' (Red, Loblolly, etc.) in texture and grain, resembles the larch in color, and is used for all purposes for which pine is employed, the excellent dimensions naturally leading to its preference for many purposes.

The wood of the Eastern Hemlock is used chiefly for dimension stuff, also for boards, and recently for pulp; but it has been well demonstrated that the wood is well suited even for finishing lumber, and that the prevailing prejudice against it is as unwarranted in the case of the Eastern as in that of the Western Hemlock. The appearance of the wood in oil finish is very satisfactory.



WAGON RACK FOR HAULING TOBACCO TO CURING BARN. DEPT OF AGR.
(See pages 587-615.)

FROST PROTECTION: HEATING ORANGE ORCHARD WITH SHEET IRON STOVES. CALIF. DEPT OF AGR.
(See pages 265-277.)

25. **DOUGLAS SPRUCE**.. (RED FIR. YELLOW FIR. OREGON PINE.) (*Pseudotsuga taxifolia* (Poir.) Britt.) Height, 300 feet +; diameter, 10 feet +.	Rocky Mountain region to Pacific; wide range; forming forests. Best development in western Oregon and Washington.	Rather heavy, hard, strong, durable. Used chiefly for *lumber* and in construction, for ties, piles, and fuel; bark employed in tanning.	Accommodates itself to many soils, but prefers a deep and moist cool and well-drained one; succeeds well on a dry slaty soil, and on sand dunes and exposed situations. Surpasses almost all of the conifers in the *rapidity* of its growth, and endures *drought* better than most of them; *shade-enduring*. One of the largest and most important forest trees of the West. For Eastern planting seed should be procured from Colorado or Montana. Repairs damage very readily.
26. **HEMLOCK** .... (*Tsuga canadensis* (Linn.) Carr.) Height, 80 feet +; diameter, 3 feet +.	Northern and Eastern States, forming forests. Best development probably in Canada.	Light, soft, rather strong, not durable; mostly fine-grained, and peculiar for holding nails well. Usually manufactured into coarse lumber; used also for ties, construction, etc. The *tan-bark* of this species is the principal one used in Northern States.	Light, alluvial loam, well-drained, but cool and moist situations. Grows slowly when young, but tolerably rapidly after four or five years; endures shade. Excellent nurse tree for white pine, with which it is usually associated.
27. **WESTERN HEMLOCK** (*Tsuga mertensiana* (Bong.) Carr.) Height, 180 feet +; diameter, 6 feet +.	Northwestern States, between 1,000 and 4,000 feet. Best development in western Oregon and Washington.	Rather heavy, hard, strong. Employed somewhat for coarse lumber; would make good finishing material. The bark contains tannin, but is too thin for economic use.	A substitute for the above species on the Pacific Coast. An exceedingly rapid grower, even on poor soils. Very shade-enduring, forming large part of the undergrowth in its habitat.

V. DECIDUOUS CONIFERS.—Though botanically not classed together, yet in forestry they may be considered allied, as the yearly fall of leaves improves the soil, while the absence of foliage during the winter and early spring distinguishes them from the evergreens, and their extreme need of light requires similar forest management. The Larches are of Northern or mountain habitat and the Bald Cypress of local southern distribution, but all are adapted to various situations. The European Larch probably surpasses the Northeastern Tamarack in every respect.

Characteristics.—Larches: Leaves in clusters, slender and soft. Cones small, egg-shaped, or elongated, with thin scales. Seeds small, triangular, nut-like in shape; mature the first year. Produces seed frequently and abundantly. Seeds keep well, but are of low percentage of germination.

Bald Cypress: Leaves single, sharp-pointed, very small and scanty, comb-like in the arrangement on the young twigs. Cones ball-like, with thick, woody scales, falling apart when mature. Seeds irregularly triangular-shaped, with hard, thick, wood-like shell; mature yearly abundantly, and keep well.

List of One Hundred Species of Trees of the United States Most Valuable for Timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate and characteristics of growth.
28. **BALD CYPRESS**..... (*Taxodium distichum* Rich.) Height, 150 feet; diameter, 8 feet.	South Atlantic and Gulf States, forming forests in swamps and pine-barren ponds.	Moderately light, soft, and stiff; *very durable* in contact with the soil. Used largely in manufacture of *lumber* for construction and interior finish, *shingles*, for ties, posts, cooperage.	Indifferent to imperfect drainage and flooding, but capable of rapid growth on well-drained, moist, sandy soils, and hardy as far north as latitude 39° and 40°, and even on Western prairies. Positively light-needing. To be recommended for extensive planting in favorable situations, where even, superior lumber may be expected.
29. *TAMARACK* .... (BLACK LARCH. HACKMATACK.) (*Larix laricina* (Du Roi) Koch.) Height, 80 feet; diameter, 1 foot +.	Northeastern (in United States). Best development probably north of the United States boundary.	Heavy, hard, very *strong; moderately durable* in contact with the soil. Employed largely for upper knees of vessels, *ship timbers*, posts, *ties, telegraph poles*, and occasionally for lumber.	North of United States boundary, found on moist uplands; south in United States, in cold, wet swamps; but probably of more value when grown on deep, moist, well-drained soils, in cool situations. Rapid and persistent grower; light-needing. Deserves attention in northern forestry, but only in mixed growths.
30. **WESTERN LARCH**.. (TAMARACK.) (*Larix occidentalis* Nutt). Height, 100 feet +; diameter, 4 feet +.	Northwestern; elevations between 2,500 and 5,000 feet. Best development in valley of Flathead River, Montana.	Heavy, very hard, strong; durable in contact with the soil. Chiefly for posts, ties, fuel, and occasionally for lumber.	An important tree as a Western representative of the foregoing species, occupying dry slopes in dry climate.

VI. CYPRESS FAMILY.—Under this head may well be grouped the junipers and so-called cedars, to which can be added the California redwoods. Characterized mostly by the shingle-like arrangement of their small, scaly leaves, the small, roundish fruit (a cone, or *berry-like?*), and by the usually upright habit of the branches and scanty fall of leaves.

Their great endurance of shade makes them valuable adjuncts to forestry; otherwise of only secondary importance. Of the many species contained in seven genera, but fourteen are found in the United States.

Wood light, soft, stiff, not strong, of fine texture; sap and heartwood distinct, the former lighter, the latter a dull, grayish brown, or red. The wood seasons rapidly, shrinks and checks but little, and is very durable. Used like soft pine, but owing to its great durability preferred for shingles, etc. Small sizes used for posts, ties, etc. Cedars usually occur scattered, but they form in certain localities forests of considerable extent.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
31. **RED JUNIPER** ...... (SAVIN.) (*Juniperus virginiana* Linn.) Height, 50 feet +; diameter, 1½ feet +.	Eastern United States.... Best development in valley of Red River, Texas.	*Light, soft,* brittle, fine-grained; very *durable* in contact with the soil. Fence posts, ties, telegraph and telephone poles, piles, cabinet-work, and almost alone for wood of lead *pencils*.	Prefers a mild climate; deep swamps, borders of streams, ridges, hills; will thrive on a rather dry, loose soil. Easily propagated from seed and cuttings. Perhaps the most important conifer for Southwestern prairie planting, enduring drought and partial shade. Tolerably rapid grower.
32. WHITE CEDAR...... (*Chamæcyparis thyoides* (Linn.),B. S. P.) Height, 70 feet +; diameter, 1½ feet +.	Atlantic and Gulf States to central Mississippi. Most abundant and best developed in Virginia and North Carolina.	Light, soft, fine-grained; *very durable* in contact with the soil. Used principally for shingles, ties, posts, telephone and telegraph poles, piles, cooperage, boat building, wooden ware.	Always in low, marshy, or wet ground, where it thrives well and grows rapidly. Endures moist, upland soils, but with slow growth. Very shade-enduring; easy to propagate from seed or cuttings.
33. PORT ORFORD CEDAR .... (*Chamæcyparis lawsoniana* (Murr.) Parl.) Height, 150 feet +; diameter, 8 feet +.	Small range; in Oregon along western coast from Coos Bay, Oregon, to Crescent City, Cal.	Light, hard, strong, close-grained; very durable lumber for interior finish, ties, posts, and for boat and ship building.	Commonly in low, moist, rich soil. Apparently hardy in the Northeastern States and succeeds on deep, rich, upland soils, and maintains itself in clay loam.
34. **YELLOW CEDAR**.... (*Chamæcyparis nootkatensis* (Lamb.) Spach.) Height, 150 feet +; diameter, 5 feet +.	Northwest coast region, from Mt. Jefferson northward. Most common on the seacoast north of United States boundary.	Light, hard, brittle, very fine-grained and durable. Cut without distinction together with Pacific arbor vitæ; largely used for doors, blinds, interior finish, cabinet-work.	Like Arbor Vitæ.
35. *ARBOR VITAE*...... (WHITE CEDAR.) (*Thuja occidentalis* Linn.) Height, 50 feet +; diameter, 1½ feet.	Northeastern States and northward.	Light, soft; not strong; *very durable* in contact with the soil. Used chiefly and largely for posts, ties, telephone and telegraph poles and shingles.	Will grow well in any soil not too stiff; often forming dense, pure growths in wet, boggy swamps. Rapid grower; easily propagated; desirable for undergrowth and to fill out places where other trees fail to come.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
36. GIANT ARBOR VITAE (RED CEDAR. YELLOW CEDAR.) (*Thuja plicata* Don.) Height, 150 feet +; diameter, 9 feet +.	Northwestern coast and from Humboldt, Cal., to British Columbia. Best development north of Seattle.	Light, soft, brittle; not strong; very durable in contact with the soil. Used principally for interior finish, cabinetmaking, shingles, cooperage, fencing. Indians of Northwest employ it exclusively for making canoes.	Like the above species, on Pacific coast.
37. INCENSE CEDAR..... (BASTARD CEDAR POST CEDAR. INCENSE CEDAR.) (*Libocedrus decurrens* Torr.) Height, 100 feet +; diameter, 6 feet +.	In interior valley between Coast range and Sierra from middle Oregon to California; between 3,000 and 8,500 feet.)	Light, soft, brittle, not strong; very durable in contact with the soil; but according to others not at all so. Used for fencing, posts, waterflumes, and other home consumption; often "pecky."	Slopes and valleys, in well-drained and dry soils. Rapid grower; of excellent appearance. In the East probably adapted only to Southern States; succeeds excellently at Washington, D. C.
38. **REDWOOD** .... (*Sequoia sempervirens* Endl.) Height, 300 feet +; diameter, 20 feet +.	California coast from Oregon southward; forest-forming.	Light, soft, brittle, not strong; very durable in contact with the soil. The chief and most valuable building timber of the Pacific Coast. In California used almost entirely for shingles, posts, ties, poles, telegraph poles, water tanks, tubs, etc.	Low, moist, well-drained situations and damp climate; not on dry hillsides. Vigorous and persisent grower; shade-enduring; sprouts from the stump. Highly important for California forestry; perhaps also for that of Southern States.
39. *BIG-TREE* .... (*Sequoia washingtoniana* (Winsl.) Sudw.) Height, 350 feet +; diameter, 35 feet +.	California; very local and isolated.	Light, soft, brittle, weak; exceedingly durable in contact with the soil. Once locally used for lumber, fencing, shingles, construction, etc.	Moist situations, between 4,000 and 6,000 feet. Probably only of historical interest.

B. BROAD-LEAFED TREES.

(With few exceptions these trees are deciduous.) Neither a strictly botanical nor a strictly practical classification in large groups has been attempted, but a sequence within botanical relations, and an arrangement according to the nature of the seed has been more or less observed, placing first the acorn and nut-bearing trees, next those with hard, wingless seeds, and lastly, those with soft and winged seeds.

THE OAKS.—Wood very variable, usually very heavy and hard, very strong and tough, porous, and of coarse texture; the sapwood whitish, the heart "oak" brown to reddish brown. It shrinks and checks badly, giving trouble in seasoning, but stands well, is durable, and little subject to attacks of insects. Oak is used for many purposes: in shipbuilding, for heavy construction, in common carpentry, in furniture, car, and wagon work, cooperage, turnery, and even in wood carving; also in the manufacture of all kinds of farm implements, wooden mill machinery, for piles and wharves, railway ties, etc. The oaks are medium to large sized trees, forming the predominant part of a large portion of our broad-leafed forests, so that these are generally "oak forests," though they always contain a considerable proportion of other kinds of trees. Three well-marked kinds—white, red, and live oak—are distinguished and kept separate in the market. Of the two principal kinds white oak is the stronger, tougher, less porous, and more durable. Red oak is usually of coarser texture, more porous, often brittle, less durable, and even more troublesome in seasoning than white oak. In carpentry and furniture work, red oak brings about the same price at present as white oak. The red oaks everywhere accompany the white oaks, and, like the latter, are usually represented by several species in any given locality. Live oak, once largely employed in shipbuilding, possesses all the good qualities (except that of size) of white oak, even to a greater degree. It is one of the heaviest, hardest, and most durable building timbers of this country; in structure it resembles the red oaks, but is much less porous.

List of One Hundred Species of Trees of the United States Most Valuable for Timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
40. **WHITE OAK** .... (*Quercus alba* Linn.) Height, 100 feet +; diameter, 3 feet +.	North Central, Central, and Eastern States. Best development on western slopes of Alleghany Mountains and valley of Ohio River.	Heavy, hard, strong, tough, durable in contact with the soil. Chiefly for shipbuilding, construction of all kinds, *cooperage*, carriage and wagon stock, *agricultural implements*, fencing, posts, ties, *piles*, cabinetmaking, interior finish, coarse lumber, and fuel.	Grows well on a great variety of soils, but best on deep, moderately moist, well-drained loamy sand, and in warm situations. Slow but persistent grower; light-needing; capable of enduring shade, but not with advantage. Most valuable of the American oaks.
41. **COW OAK** .... (SWAMP CHESTNUT OAK, BASKET OAK.) (*Quercus michauxii* Nutt.) Height, 100 feet +; diameter, 3 feet +.	Southeastern .... Best development on the rich bottom lands of southeastern Arkansas and Louisiana.	Equal to the White Oak.......... Largely employed in the manufacture of agricultural implements, wheel stocks, cooperage, baskets, fencing and fuel.	Moist, rich soil; will endure flooding. The most valuable of the White Oaks for the Gulf States.
42. **CHINQUAPIN OAK**.. (*Quercus acuminata* (Michx.) Houba.) Height, 80 feet +; diameter, 3 feet +.	Central and Middle Atlantic region. Largest growth in lower Ohio Valley.	Very much like White Oak....... Employed largely in cooperage, wagonmaking, for ties, posts, and coarse lumber.	Best in deep, rich, moist, well-drained bottom lands, but grows well and is not uncommon on dry, fertile limestone soils; it also succeeds on clayey and sandy soils of uplands.
43. LIVE OAK........... (*Quercus virginiana* Miller.) Height, 80 feet +; diameter, 3 feet +.	Southern States .... Greatest development in Southern Atlantic States.	Very heavy, hard, ***strong***, tough, and durable. Once largely employed in shipbuilding, but now only occasionally; somewhat for tool stock.	Warm, loamy soil, retentive of moisture, and free from overflow. One of the most *rapid* growers *of all the oaks; most shade-enduring;* evergreen foliage. Especially desirable for Southern forestry.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate and characteristics of growth.
44. *CANON LIVE OAK*... (MAUL OAK. VALPARAISO OAK.) (*Quercus chrysolepis* Liebm.) Height, 80 feet +; diameter, 5 feet +.	Pacific States, 3,000 to 8,000 feet elevation.	Very heavy, hard, tough; very strong. Employed considerably in the manufacture of agricultural implements, wagons, etc.	Warm, dry, sunny exposures. Most valuable of the Pacific oaks. Foliage evergreen.
45. TAN-BARK OAK..... (PEACH OAK.) (*Quercus densiflora* Hook & Arnott.) Height, 60 feet +; diameter, 2 feet +.	Pacific coast .... Best development in redwood belt on California coast.	Heavy, hard, strong; inferior to other white oaks; valued chiefly for tan bark.	Well drained, rich soils. Shade-enduring. Foliage evergreen.
46. CHESTNUT OAK (ROCK CHESTNUT OAK.) (*Quercus prinus* Linn.) Height, 80 feet +; diameter, 3 feet +.	Northeastern .... Best development in southern Allegheny Mountains.	Somewhat less valuable than White Oak. Less valuable than the foregoing species. Used chiefly for fencing, ties, and somewhat for coarse lumber. Valued principally for *tan bark.*	For planting on rocky banks and hillsides; never in any but well-drained situations.
47. **BUR OAK** .... (MOSSY-CUP OAK. OVER-CUP OAK.) (*Quercus macrocarpa* Michx.) Height, 100 feet +; diameter, 3½ feet +.	Mainly Northeastern United States; extends farthest west and northwest of any of the Eastern oaks.	Heavy, hard, strong, tough; most *durable* in contact with the soil of any of American oaks. Employed for the same purposes as that of White Oak; more durable but porous.	Requires better soil than White Oak—deep, rich loam; more shade-enduring. A Western substitute for White Oak, and especially recommended for prairie planting.
48. **POST OAK** .... (IRON OAK.) (*Quercus minor* (Marsh.) Sarg.) Height, 80 feet +; diameter, 2½ feet +.	East of the Rocky Mountains.	Equal to White Oak............. Chiefly for fencing, ties, fuel, and occasionally for carriage stock, cooperage, and other construction; usually not distinguished from White Oak in the market.	Well-drained, gravelly uplands, clay barrens, and poor sandy loams. Recommended for Western planting.

49. OVERCUP OAK......	Southeastern United States	Like the White Oak and used for same purposes.	Chiefly in wet or submerged swamps, but grows well in well-drained bottom lands and on rich, gravelly or sandy loam uplands.
(*Quercus lyrata* Walt.)	Best developed in Arkansas and adjacent Texas.		
Height, 80 feet +; diameter, 2 feet +.			
50. SWAMP WHITE OAK	Northeastern United States	Like the White Oak and used for the same purposes, but perhaps more durable in contact with the soil.	In deep moist or inundated swamps and low banks of water courses. Succeeds in all loose, rich, fairly moist upland soils.
(*Quercus platanoides* (Lam.) Sudw.)	Best development in region south of the Great Lakes		
Height, 90 feet +; diameter, 2 feet +.			
51. **RED OAK**	East of Rocky Mountains	Heavy, hard, strong; inferior in quality to White Oaks.	Thrives in all soils, except an undrained one.
(*Quercus rubra* Linn.)	Most northerly of Atlantic oaks.	Largely employed for cooperage, manufacture of furniture, and for interior finish. Important for *tan-bark.*	The most *rapid* in growth of all the oaks. Sprouts vigorously from stump; of importance for tan-bark coppices.
Height, 100 feet +; diameter, 3½ feet +.	Best development in Massachusetts.		
52. **BLACK OAK**	East of longitude 96°, United States.	Heavy, hard, strong, not tough....	Gravelly uplands; poorer soils than White Oak requires.
(YELLOW-BARK OAK. YELLOW OAK. QUERCITRON OAK.)	Best development in North Atlantic States.	Used for cooperage, agricultural implements, construction, and extensively for furniture and interior finish. Superior to White Oak for some purposes. Important for tan bark.	Next to the Red Oak in rapidity of growth.
(*Quercus velutina* Lam.)			
Height, 80 feet +; diameter, 3 feet +.			
53. SPANISH OAK	Central, Southeastern, and Southern States.	Heavy, very hard and strong; not durable.	Dry, barren soils; rapid grower.
(RED OAK.)	Best development in South Atlantic and Gulf States.	Used for cooperage, construction, and fuel. Important for tan bark.	
(*Quercus digitata* (Marsh.) Sudw.)			
Height, 80 feet +; diameter, 3 feet +.			

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
54. WATER OAK........ (DUCK OAK. POSSUM OAK. SPOTTED OAK.) (*Quercus nigra* Linn.) Height, 75 feet +; diameter, 3 feet +.	Central, Southern, and Southeastern States. Greatest development in eastern Gulf region.	Heavy, hard, strong.............. Chiefly for fuel; also for cooperage and construction—hewn and sawn dimension timber sometimes passing for White Oak in inspection.	Heavy undrained soil; exceedingly rapid grower. A useful *concomitant* in Southern planting.
55. **BEECH** .... (*Fagus atropunicea* (Marsh.) Sudw.) Height, 100 feet +; diameter, 3 feet +.	East of Mississippi and Missouri rivers. Best development probably on "bluff" formations of Lower Mississippi basin.	Heavy, hard, stiff, strong, of rather coarse texture; white to light brown; not durable in the ground, and subject to the inroads of boring insects; shrinks and checks considerably in drying; works and stands well and takes a good polish. Used for furniture, in turnery, for handles, lasts, etc.	Fresh, rich, but not necessarily a deep soil; limestone soils. For rocky, exposed situations. Rapid grower and *enduring shade* exceedingly well, a fact which renders it one of the most valuable aids to forestry.
56. CHESTNUT .... (*Castanea dentata* (Marsh.) Borkh.) Height, 90 feet +; diameter, 14 feet +.	Northeastern and Middle Atlantic States. Best development on western slopes of Allegheny Mountains.	Light, moderately soft, stiff, not strong, of coarse texture. Shrinks and checks considerably in drying, works easily, stands well, and is very durable. Used in cabinetwork, cooperage, for railway ties, telegraph poles, and locally in heavy construction	*Well drained* gravelly soils; succeeds on rocky hillsides with soil of sufficient looseness and depth; on northern and eastern exposures; will thrive on rather poor sand; slow and uncertain in stiff, clayey soil; on limestone only when well fissured. Exceedingly *rapid* grower; moderately shade-enduring; sprouts most vigorously and *persistently* from the stump; *large yield per acre.*
57. **BLACK WALNUT**... (*Juglans nigra* Linn.) Height, 100 feet +; diameter, 4 feet +.	Northeastern, Central and Southeastern States. Best development on southern slopes of Allegheny Mountains and in bottom lands of southwestern Arkansas and Indian Territory.	Wood heavy, hard, strong, of coarse texture. Shrinks moderately in drying; works and stands well; takes a good polish; for a long time the favorite cabinet wood in this country; the dark heart wood used largely as a veneer for inside finish and cabinetwork; also in turnery, for gunstocks, etc.	Deep, loose, fresh to moist, warm, and sandy loam; will grow in a dry and compact soil, but not in a wet one. Hardy and rapid grower, especially in height; only centenarians produce first-class quality of lumber, but useful timber may be produced in 40 to 60 years. Sprouts freely from the stump. Not recommended for arid or subarid regions nor for uplands.
58. *BUTTERNUT* .... (WHITE WALNUT.) (*Juglans cinerea* Linn.) Height, 80 feet +; diameter, 2 feet +.	Northeastern States ..... Best development in basin of Ohio River.	Light, soft, durable, not strong.... Employed chiefly for cabinetwork and interior finish.	Prefers a deep, rich, *cool* loam; suited to cooler sites and colder climate than the foregoing species. Rapid grower when young.

THE HICKORIES, AND OTHER HARD-SEEDED VARIETIES.—*The Hickories.*—Wood very heavy, hard, and strong, tough, of rather coarse texture, smooth, and of straight grain. The broad sapwood white, the heart reddish nut brown. It dries slowly, shrinks and checks considerably; is not durable in the ground, or if exposed, and, especially the sapwood, is always subject to the inroads of boring insects.

Hickory excels as carriage and wagon stock, but is also extensively used in the manufacture of implements and machinery, for tool handles, timber pins, for harness work and cooperage. The hickories are tall trees with slender stems, never form forests, occasionally small groves, but usually occur scattered among other broad-leafed trees in suitable localities. The following species all contribute more or less to the hickory of the markets:

List of One Hundred Species of Trees of the United States Most Valuable for Timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
59. **SHAGBARK HICKORY** .... (SHELLBARK HICKORY.) (*Hicoria ovata* (Mill.) Britt.) Height, 100 feet +; diameter, 2 feet +.	Eastern United States; wide range. Best development west of the Allegheny Mountains.	Very heavy, very hard, strong, *tough, elastic; not durable* in contact with the soil or exposed to the weather. Used chiefly for agricultural implements, *carriage stock,* ax and tool handles, baskets, etc.; best fuel.	Deep, fresh soil; a compact soil not objectionable; not on poor, dry, or wet soils. At first slow, but afterwards rapid grower; sprouts well from the stump. Moderately shade enduring. Somewhat liable to injury by frost.
60. BITTERNUT .... (PIGNUT SWAMP HICKORY.) (*Hicoria minima* (Marsh.) Britt.) Height, 80 feet +; diameter, 2 feet +.	Eastern United States; wide range.	Heavy, rather hard, strong, tough; less valuable than that of Shagbark Hickory. Largely for ox yokes, hoop poles, and fuel.	To replace Shagbark Hickory on low, moist, or wet ground. Sprouts well from the stump. Less liable to frost than Shagbark Hickory, but more subject to the ravages of insects.
61. MOCKERNUT .... (BULLNUT. KINGNUT. BLACK HICKORY. BIG-BUD HICKORY. WHITE HEART HICKORY.) (*Hicoria alba* (Linn.) Britt.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States; wide range. Most abundant and generally distributed in the Southern States.	Very heavy, hard, tough, strong... Used for much the same purposes as that of Shagbark Hickory, very variable according to site; resembling Shagbark Hickory.	To replace Shagbark Hickory on poorer and drier soils; will succeed even on *barrens.* Sprouts well from the stump, but slow grower; liable to attacks of insects.
62. SHELLBARK HICKORY .... (BOTTOM SHELLBARK.) (*Hicoria laciniosa* (Michx. f.) Sarg.) Height, 70 feet +; diameter, 3 feet +.	Central United States; local.	Like Shagbark Hickory, and employed for much the same purposes.	Rich, deep soil; especially adapted to well-drained bottom lands, but succeeds with slower growth on drier uplands. Climatically confined.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
63. PECAN .... (ILLINOIS NUT.) (*Hicoria pecan* (Marsh.) Britt.) Height, 75 feet +; diameter, 2 feet +.	Southwestern, but widely cultivated in Southern States. Best development in Arkansas and Indian Territory.	Like Shagbark Hickory .... Used chiefly for handle stocks, etc. Edible *nuts* an important article of commerce.	Deep, rich bottom land, but succeeds fairly on upland soils of moderate richness. Rapid grower; for Southwestern planting. More valuable perhaps for production of fruit than for timber purposes.
64. BLACK CHERRY.... (RUM CHERRY.) (*Prunus serotina* Ehrhart.) Height, 90 feet +; diameter, 2 feet +.	Eastern United States; wide range.	Rather heavy, hard, strong. Of light-red color. Chiefly for *cabinetwork* and *interior finish.*	Adapted to almost any soil and situation; best in deep, well-drained soil; will succeed also on dry soil. Very rapid grower, very soon reaching a useful size for cabinet wood. Endures considerable *shade* when young. The *wide range of sites* to which it is adapted, its rapid growth and endurance of shade place it among the most valuable forest trees of the United States, especially for Western planting. Not infected by caterpillars in forest plantations.
65. SWEET GUM. .... (LIQUIDAMBER. RED GUM. STAR-LEAVED GUM. BILSTED.) (*Liquidambar styraciflua* Linn.) Height, 100 feet +; diameter, 3 feet +.	Southeastern States ..... Greatest development in basin of Mississippi River.	Rather heavy and soft; strong, stiff, tough, not durable when exposed to the weather; shrinks and warps readily. Manufactured into lumber, clapboards, and coarse boards, mottled forms becoming popular for cabinetwork, veneering plates, hat blocks, baskets, etc.	Succeeds on a great variety of soils; a tree of the swamp as well as of dry soils; best on light, dry, sandy and soils retentive of moisture. Rapid grower. Insect proof and generally healthy.
66. LOCUST .... (LOCUST. YELLOW LOCUST.) (*Robinia pseudacacia* Linn.) Height, 80 feet +; diameter, 1½ feet +.	Southern Allegheny region. Allegheny Mountains; local; but by cultivation widely distributed east of Rocky Mountains.	Heavy, very hard and strong; very *durable* in contact with the soil; shrinks considerably and suffers in seasoning. Employed largely for *fence posts,* in turnery, construction, treenails, wagon hubs, etc.	Poor, loose sands give best quality of timber; not succeeding well in compact soils, but will thrive on a thin one, and grows quickest on a rich, sandy loam. Very *rapid* grower while young; needs light very much; sprouts *persistently* and *vigorously from the roots.* To be only sparingly dispersed among shady companions, which will afford protection against the attacks of borers. Easily propagated from seed, also by cuttings, suckers, and stakes. For short rotations and coppice management.

67. HONEY LOCUST ..... (SWEET LOCUST. HONEY SHUCKS. THREE-THORNED ACACIA. BLACK LOCUST.) (*Gleditsia triacanthos* Linn.) Height, 90 feet +; diameter, 2 feet +.	Central States .... Best development in bottom land of lower Ohio River basin. Widely cultivated for hedges and ornament.	Heavy, hard, strong; very *durable* in contact with the soil. For *fence posts,* rails, hubs, construction, etc.	Low, rich bottom land; rarely on high, dry, sterile hills; but often common on rich uplands, where it grows rapidly. Very *rapid grower; needs light.* Easily grown from seed, but not from cuttings. Less liable to insect ravages; otherwise to be treated like Black Locust, which it is recommended to replace in Southern localities.
68. *HACKBERRY* .... (NETTLE-TREE.) *Celtis occidentalis* Linn.) Height, 80 feet +; diameter, 3 feet +.	Northern and mainly east of the Rocky Mountains. Best development in basin of Ohio River.	Heavy, hard, strong; difficult to split; shrinks moderately; works well. Employed chiefly for fencing, but occasionally in the manufacture of cheap furniture.	Will grow tolerably well on the most barren and poorest soils, but best in a fertile one, cool and moist, where it is of rapid growth. In Western planting recommended only as an adjunct.
69. *RED MULBERRY* .... (*Morus rubra* Linn.) Height, 60 feet +; diameter, 2 feet +.	East of longitude 98°.... Best development in basins of lower Ohio and Mississippi rivers.	Rather heavy, hard, strong, and very durable. Employed for fence posts, in cooperage, snaths, and other tool stock, boat-building, etc.	Deep, rich loam, but grows well on poorer dry soil; endures shade. For Southwestern planting.
70. *MAGNOLIA* .... (SOUTHERN EVERGREEN. BIG LAUREL. BULL BAY.) (*Magnolia fœtida* (Linn) Sarg.) Height, 70 feet +; diameter, 2 feet.	Southern and Gulf States. Best development along Mississippi in Gulf region.	Heavy; of medium weight, hardness, and strength; very white. Suitable for cabinetwork and interior finish.	Cool, moist hummocks, with rich, deep, loose soil. Not hardy in Northern States; for strictly Southern climate.
71. CUCUMBER TREE ... (*Magnolia acuminata* Linn.) Height, 90 feet +; diameter, 3 feet +.	Mainly Middle Atlantic region. Best development in the southern Allegheny Mountain region.	Light, soft, moderately durable. Closely resembling the Tulip-tree, and used for the same purposes.	In cool, moist, deep, rich soils of mountain slopes, valleys, and "coves." Succeeds also in fresh sandy or gravelly soils of moderate richness.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
72. **TULIP-TREE**	Eastern States	Light, soft, stiff, not strong, nor very durable; shrinks, but seasons without much injury.	Deep, light, loamy, sandy, or clayey soils, in cool, moist situations.
(WHITE WOOD. YELLOW POPLAR.)	Greatest development in valley of lower Wabash River, and on Western slope of Allegheny Mountains in Tennessee, North Carolina, and the Virginias.	Manufactured into *lumber* for interior finish, boxes, shelving, clapboards, panels of carriages, shingles, cheap furniture; pumps, wooden ware, boat building.	Tolerably rapid and persistent grower. Needs light very much; hardy.
(*Liriodendron tulipifera* Linn.)			Poor seeder, and low percentage of germination; seed to "lie over." Sprouts fairly from stump. One of the largest and most valuable of the deciduous soft woods.
Height, 120 feet +; diameter, 4 feet +.			
73. HARDY CATALPA...	South Central States; rare, but widely cultivated for ornament.	Light, soft, not strong; *very durable* in contact with the soil.	Adapted to a great variety of soils; best on low, rich bottom lands.
(*Catalpa speciosa* Warder.)	Best development in valley of lower Wabash River.	Employed chiefly for *ties, posts,* rails; suitable for interior finish and used somewhat for cabinet wood.	Very rapid grower; sprouts vigorously from the stump; *shade enduring.* Good seeder and keeper. Readily propagated from seed, cuttings and layers.
Height, 80 feet +; diameter, 3 feet +.			Desirable tree for Western planting. Foliage subject to ravages of insects.
74. COMMON CATALPA..	Gulf States, but widely cultivated for ornament.	Like the Hardy Catalpa, and used for the same purposes in the South.	Like the preceding, to be used in Southwestern planting, to which it is best adapted.
(*Catalpa catalpa* (Linn.) Karst.)			
Height, 40 feet +; diameter, 1½ feet +.			

The Ashes, Maples, Elms and Other Varieties.—Wood heavy, hard, strong, stiff, quite tough, not durable in contact with soil, straight grained, rough on the split surface, and coarse in texture. The wood shrinks moderately, seasons with little injury, "stands" well, and takes a good polish. In carpentry ash is used for finishing lumber, stairways, panels, etc.; it is used in shipbuilding, in the construction of cars, wagons, carriages, etc., in the manufacture of farm implements, machinery, and especially of furniture of all kinds, and also for harness work; for barrels, baskets, oars, tool handles, hoops, clothespins, and toys. The trees of the several species of ash are rapid growers, of small to medium height with stout trunks; they form no forests, but occur scattered in almost all our broad-leafed forests.

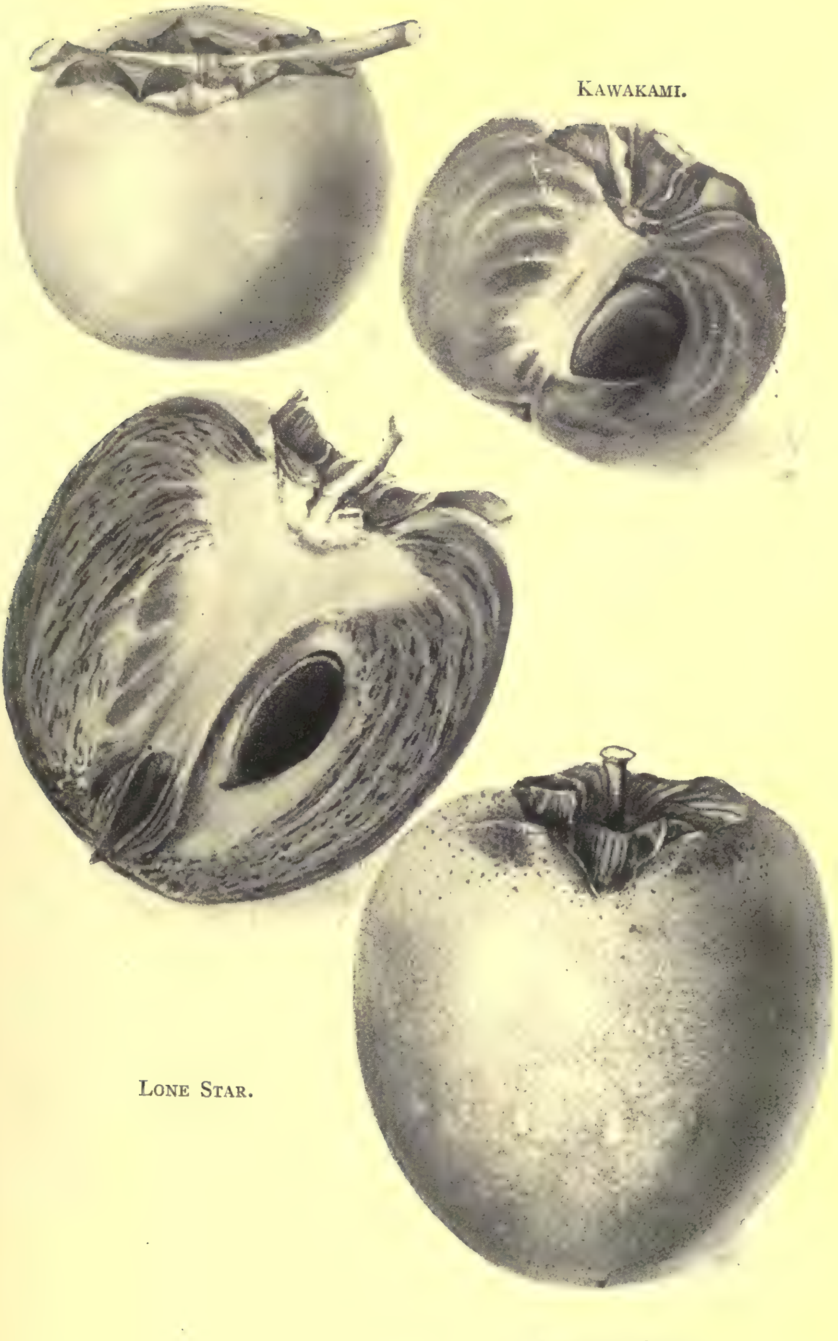
List of One Hundred Species of Trees of the United States Most Valuable for Timber.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
75. **WHITE ASH**......... (*Fraxinus americana* Linn.) Height, 100 feet +; diameter, 3 feet +.	Eastern; wide range..... Best development in lower Ohio basin.	Heavy, hard, *strong, very elastic;* old timber brittle. Very valuable. Employed chiefly in the *manufacture* of agricultural implements, carriages, handles, oars, interior finish, cabinetwork, furniture, and flooring.	Depth, looseness, and moisture of soil of most importance. Best in moist atmosphere of northern and eastern exposures. Will succeed in wet and compact soil if well drained, but maintains itself with slow growth in a light and dry one. Rapid grower; light needing; thinning out rapidly, and therefore requiring shady, slower-growing companions. Sprouts vigorously and persistently from the stump. Often a poor seeder; seed not easily kept, tending to "lie over." Liable to attacks of borer and to frost when young.
76. **BLACK ASH**......... (Hoop Ash. Ground Ash.) (*Fraxinus nigra* Marsh.) Height, 90 feet +; diameter, 2½ feet +.	Northern and Northeastern States. The most northerly of the ashes.	Rather heavy, rather soft, tough, *elastic,* not very durable when exposed. Lately much used for interior finish and cabinetwork, fencing, barrel hoops, baskets, and fuel.	Soils like those for *F. americana*, but *indifferent* to *drainage*, and more dependent on moisture; therefore well adapted to undrained situations in cool climate; otherwise like *americana.*
77. GREEN ASH......... (*Fraxinus lanceolata* Borkh.) Height, 50 feet +; diameter, 1½ feet +.	Western States east of Rocky Mountains and South; most common and best developed in the Mississippi Valley.	Heavy, hard, strong.............. Often employed for same purpose as that of White Ash, but somewhat inferior to it in quality.	Less dependent on humidity of soil than the White Ash, but prefers a deep, cool, moist soil, and will succeed even on inundated lands. Rapid but not persistent grower. Seed germinates readily. The ash for Western planting.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate and characteristics of growth.
78. BLUE ASH.......... (*Fraxinus quadrangulata* Michx.) Height, 70 feet +; diameter, 2 feet +.	Central States........... Best development in basin of lower Wabash River.	Heavy, hard; as valuable as any of the ashes, and *most durable of* all when exposed to alternate dryness and moisture. Used for much the same purposes as that of White Ash, but principally in *carriage making* and flooring. Very superior for hay fork and other tool handles.	Less dependent on moisture than other ashes; prefers a rich, deep, moist soil, and grows well on dry limestone soils. Recommended for western planting.
79. OREGON ASH........ (*Fraxinus oregona* Nutt.) Height, 60 feet +; diameter, 1½ feet +.	Northwestern coast region Best development in bottom lands of southwestern Oregon.	Rather heavy, sometimes brittle, not strong; similar to that of White Ash. Employed chiefly in the manufacture of furniture, carriage and wagon frames, cooperage, fuel.	Moist soils and climate.
80. **SUGAR MAPLE**...... (HARD MAPLE. SUGAR-TREE.) (*Acer saccharum* (Marsh.) Height, 100 feet +; diameter, 3 feet +.	Eastern United States and northward. Best development in region of the Great Lakes.	Heavy, *hard, strong,* tough; not durable, and subject to attack of boring insects. Employed chiefly in the *manufacture* of furniture, shoe lasts and pegs, saddle-trees, turnery, interior finish, flooring; in shipbuilding, for keels, keelsons, shoes; *excellent fuel.* The "bird's-eye" and "curled" maple of this species are much prized in cabinetmaking. Furnishes the maple sugar of commerce.	Best on moderately deep, loose, well-drained, strong, loamy, and calcareous soil, in moist, cool position; will grow also on stiff clay, if not too wet, and on stony hillsides, if not too dry. Tolerably rapid and persistent grower; moderately shade enduring; does not sprout well from the stump. Not well adapted to dry regions.
81. SILVER MAPLE..... (WHITE MAPLE. SOFT MAPLE.) (*Acer saccharinum* Linn.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States... Best development in basin of lower Ohio River.	Rather heavy, soft, brittle, not very strong, nor durable when exposed to the weather or soil. Used in the manufacture of furniture, flooring, for fuel. Yields a good quality of maple sugar.	Adapted to a variety of soils and climates, but best on rich, moist soil. *Very rapid* but not persistent grower; light needing; sprouts vigorously from the stump; liable to injury from winds; comparatively free from insects. Especially recommended as a nurse in Western planting.
82. RED MAPLE........ (SOFT MAPLE. WATER MAPLE. SWAMP MAPLE.) (*Acer rubrum* Linn.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States and northward; wide range. Greatest development in valleys of lower Wabash and Yazoo Rivers.	Slightly heavier and hardier than that of Silver Maple; not strong nor durable; inferior to that of Sugar Maple, but superior to Silver Maple. Used chiefly for cabinetmaking, in turnery, for woodenware, gunstocks, light fuel.	Best on low, wet soils, but will thrive in moderately dry situations. Rapid but moderately persistent grower; endures more *shade* than *A. saccharinum* L.; sprouts vigorously from the stump. Usefulness in dry climates questionable.

83. **OREGON MAPLE**.... (CALIFORNIA MAPLE. BROAD-LEAFED MAPLE.) (*Acermacrophyllum* Pursh.) Height, 90 feet +; diameter, 4 feet +.	Pacific slope .... Best development on rich bottom lands of southern Oregon.	Rather light, hard, strong; said to be one of the best and most valuable woods of Pacific coast. In Oregon, employed largely in the manufacture of furniture, ax and broom handles, snowshoe frames, etc. The "curled" wood of this species is highly prized in cabinet-making.	Rich bottom lands. Rapid grower in moist climate. Important on the Pacific slope.
84. *BOX ELDER* .... (ASH-LEAVED MAPLE.) (*Acer negundo* Linn.) Height, 50 feet +; diameter, 2 feet +.	East of Rocky Mountains, rather Southern and Western. Best development in valleys of Wabash and Cumberland rivers.	Light, soft, not strong; inferior.... Manufactured chiefly into paper pulp, wooden ware, and used somewhat in cooperage and for interior finish, fuel, etc.	Best on low, rich ground, but will succeed on upland. Rapid but not persistent grower; sprouts well from the stump; hardy. *Easily propagated.* For forestry purposes, imported only as *nurse* and soil cover, especially in western planting.
85. **WHITE ELM**........ (AMERICAN ELM. WATER ELM.) (*Ulmus americana* Linn.) Height, 100 feet +; diameter, 3½ +.	East of the Rocky Mountains. Probably attains its best developments near its northern limits.	Heavy, hard, strong, very *tough*, but not durable; inferior; often difficult to split. Employed principally for wheel and chair stock, coarse lumber, flooring, furniture, cooperage, and fuel.	Adapted to a great variety of soils, but best on a rich, loose, moist one; requires less moisture than the ashes; bears occasional flooding. Rapid and persistent grower; sprouts well; endures moderate shade. Important in forestry mainly as a *nurse* and for soil cover. Recommended for western planting.
86. **CORK ELM** .... (HICKORY ELM. WHITE ELM. CLIFF ELM.) (*Ulmus racemosa* Thomas.) Height, 90 feet +; diameter, 2 feet +.	Northeastern United States Best development in southern Ontario and Michigan.	Heavy, hard, very strong, tough, and *elastic;* superior to that of other elms. Extensively used in the *manufacture* of agricultural implements, wheel stock, for ties, bridge-building and ship timber, rails, bicycle rims, and all places where a very tough noncleavable wood is needed.	Rich, moist, heavy, loamy soils. Probably to take the place of the White Elm in forestry.
87. *WING ELM* .... (*Ulmus alata* Michx.) Height, 80 feet +; diameter, 2 feet +.	Southeastern United States Best development west of the Mississippi River.	Heavy, hard, tough. Used for wheel stock, tool handles, coarse lumber, and fuel.	Most commonly on dry, gravelly uplands, but frequently in moist bottoms and along water courses. Very adaptive and to be used in Southwestern planting in place of the White Elm.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
88. ***SLIPPERY ELM*** .... (Red Elm. Moose Elm.) (*Ulmus pubescens* Thomas.) Height, 60 feet +; diameter, 2 feet +.	Northern Atlantic and Gulf States. Best development in Western States.	Heavy, hard, strong; more durable than other elms. Used principally for wheel stock, sills, posts, ties, rails, fuel. Large quantities of the inner bark used for medicinal purposes.	Rich, moist, well-drained soil; much like that of the White Elm, but will bear drier and more elevated situations. Rapid, but not persistent grower. Easily propagated.
89. YELLOW BIRCH.... (Gray Birch.) (*Betula lutea* Michx. f.) Height, 80 feet +; diameter, 3 feet +.	Northeastern United States and northward. Best development north of the Great Lakes.	Heavy, hard and strong .... Chiefly for furniture, wheel hubs, pill and match boxes, button and tassel molds, and extensively for *fuel.* Valuable for *cabinet* wood and building purposes.	Cool, moist atmosphere preferable. Capable of thriving on poor, but best on a moderately deep, loose, moist sand; hardy and very adaptive as to soils. Rapid and tolerably persistent grower; sprouting qualities greatly dependent on site. Vigorously in moist soils. Light needing. Easily propagated.
90. SWEET BIRCH...... (Cherry Birch. Mahogany Birch.) (*Betula lenta* Linn.) Height, 60 feet +; diameter, 3 feet +.	Same range as Yellow Birch.	Heavy, very strong, hard like that of Yellow Birch, but rose-colored, and perhaps more valuable for cabinet-work. Much used in the manufacture of *furniture* and for fuel.	Same as above species, but apparently not as rapid nor as persistent a grower.
91. RIVER BIRCH...... (*Betula nigra* Linn.) Height, 80 feet +; diameter, 3 feet +.	Eastern States .... Best developed in the South Atlantic and Lower Mississippi Valley regions.	Rather light, hard, strong, close grained, considerably used for furniture, interior finishing, turnery, bowls, other wooden ware, and fuel.	Almost exclusively on moist or inundated bottoms, along streams, and near ponds. Succeeds very well on moist, rich, porous, upland soils. Important as a substitute for Northern birches in Southwestern planting.
92. ***CANOE BIRCH***...... (White Birch. Paper Birch.) (*Betula papyrifera* Marshall.) Height, 60 feet +; diameter, 2 feet +.	Northwestern, Northern, and Northeastern in United States. Reaches a higher latitude than any other American deciduous tree.	Rather heavy, hard, tough, strong; not durable. Extensively employed in the manufacture of spools, shoe lasts and pegs, *turnery* of other kinds; lately much used in making *pulp;* excellent *fuel.*	Mostly on sandy soils in northern climates. Not on clay lands where the Yellow Birch thrives.
93. ***WHITE BIRCH***...... (Old-field Birch. Gray Birch.) (*Betula populifolia* Marsh.) Height, 30 feet +; diameter, 1 foot +.	Northeastern coast region	Rather heavy, soft, not strong nor durable. Employed largely for spools, shoepegs, *wood pulp,* hoop poles and fuel.	Adapted to drier and poorer soils than other birches. Short-lived; rapid grower; *sprouts readily* from the stump. Probably least important of the birches.



PERSIMMONS.

(See pages 280–283.)

94. **BASSWOOD** .... (American Linden. Bee-tree. Lime-tree.) (*Tilia americana* Linn.) Height, 100 feet +; diameter, 3 feet +.	East of the Mississippi and Missouri rivers; wide range. Greatest development in valley of lower Wabash River.	Light, soft, not strong; easily worked. Employed largely in the manufacture of wooden ware, cheap furniture, *paper pulp*, for *panels*, bodies of carriages, clapboards, lumber, in turnery, and for bakers' light fuel.	Deep, moderately loose, and somewhat moist soil; can endure a wet soil, but will not thrive on a dry one. Rapid and persistent grower; sprouts vigorously from the stump; endures moderate shade. Not very hardy, but in cool situations a desirable adjunct in forestry.
95. WHITE BASSWOOD. . (*Tilia heterophylla* Vent.) Height, 60 feet +; diameter, 3 feet +.	Middle and South Atlantic region. Best development in southern Alleghenies.	Like the preceding; not being distinguished in the market, and used for the same purpose.	Deep, rich, moist, well-drained soils of mountain coves, lower slopes, and on the banks of streams; frequent also on rich limestone soils of the plain, and succeeds on dry, gravelly, clayey, and sandy soils of moderate richness; important for Southern planting in place of the Northern basswood.
96 SYCAMORE .... (Buttonwood. Button-ball-tree. Water Beech.) (*Platanus occidentalis* Linn.) Height, 120 feet +; diameter, 6 feet +.	East of the Mississippi and Missouri rivers. Best development in bottom lands of the Ohio and Mississippi rivers.	Rather heavy, rather hard, not very strong. Extensively used in the manufacture of cigar and tobacco boxes, furniture, interior, for butchers' blocks, ox yokes, and coarse planks; lately much used for making butter and lard trays and wooden bowls. Little used for fuel, owing to difficulty in splitting.	Rich, moist, soil, low ground, thriving in swamps subject to overflow; grows well on moist upland. Wide climatic range, but liable to frost when young; light needing; secondary in forestry.
97. COTTONWOOD ...... (Carolina Poplar. Big Cottonwood. Necklace Poplar.) (*Populus deltoides* Marsh.) Height, 100 feet +; diameter, 4 feet +.	East of the Rocky Mountains.	Very light, soft, not strong and durable. The wood shrinks moderately (some crossgrained forms warp excessively), but checks little; is easily worked. Used as building and furniture lumber, in cooperage for sugar and flour barrels, for crates and boxes (especially cracker boxes), for wooden ware, and paper pulp.	Adapted to a variety of soils, but best in a moist, strong, loamy one. Exceedingly *rapid* grower; sprouts vigorously from the stump; light needing; *thinning out rapidly;* short lived and exhaustive to the soil; most readily propagated. Has been recommended for planting on Western prairies, chiefly on account of its rapidity of growth, ease of procuring plant material, and of propagation. In forestry should be used only as a nurse with better and shady kinds.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
98. *LARGE-TOOTH ASPEN* .... (WHITE POPLAR.) (*Populus grandidentata* Michx.) Height, 60 feet +; diameter, 2 feet +.	Northern and Northeastern States.	Light, soft, not strong nor durable.. Employed chiefly in the manufacture of wood pulp, and used somewhat in turnery and for wooden ware.	Northern States, in moist situations; grows well in all fresh upland soils.
99. *BALM OF GILEAD*... (BALSAM POPLAR. TACAMAHAC.) (*Populus balsamifera* Linn.) Height, 70 feet +; diameter, 3 feet +.	Northern United States..	Very light, soft, not strong. Quality of timber quite equal to that of any poplars, but little used where it is abundant, except for pulp. Suitable for wooden ware and uses like cottonwood.	A substitute for cottonwood in the most northern localities. Thrives in moist, rich, well-drained soils.
100. *ASPEN* .... (AMERICAN ASPEN.) (*Populus tremuloides* Michx.) Height, 50 feet +; diameter, 1½ feet +.	Northern and Southwestern (in United States); in Pacific region, from 6,000 to 10,000 feet elevation.	Light, soft, not strong nor durable. Employed largely in the manufacture of paper pulp; in Pacific region used occasionally for flooring, in turnery, and for fencing and light fuel.	Of value mainly as a tree naturally covering denuded mountain sides and as a quick-growing nurse for better kinds. —(G. B. 1897; F. S. B. 17.)

SOURCES OF FURTHER INFORMATION FOR THE FARMER.

For the benefit of the farmer who has local forestry problems to solve, the following lists of forestry associations, schools, and institutions giving instruction in forestry are offered to which he may write in addition to the Bureau of Forestry, Department of Agriculture, Washington, D. C. In most instances the school of his own State will be in connection with the State Experiment Station. The following institutions and associations will also show him in a clear, concise way the extent of and interest in scientific and economic forestry in the United States. Co-operative forestry in which the farmer is interested, such as planting on hillsides or along streams to protect a public road, or for mutual profit, is a local problem in which the most valuable information can usually be obtained at the State Experiment Station where all the conditions are understood.

PART III

FLORICULTURE.

LANDSCAPE GARDENING FOR THE COUNTRY HOME.

Vegetation about the home is beneficial in many ways. It adds to the healthfulness of the home by cooling and purifying the air. Besides cutting off the direct and reflected rays of the sun, foliage exercises a marked effect on the temperature by evaporating large quantities of water from its surface, and the reduction of the temperature in this way is greatest on dry, hot days when it is most needed. Leaves also absorb impure and hurtful gases and set free the oxygen needed by animals for respiration. Circulation of the air, due to unequal temperature, is likewise promoted by vegetation properly pruned and arranged; while the air of basements and cellars is rendered less humid by the removal of surplus water from the surrounding soil through the medium of roots and foliage. Vegetation adds materially to the comforts of life and also gives pleasure. It softens the hard door yard lines and adds attractive forms and colors to the monotony of bare walls and buildings. Its bright green foliage is eagerly watched for in the spring and the changing colors are a constant source of pleasure in autumn. The most attractive homes are those where beautiful lawns are most abundant. Vegetation also adds greatly to the value of property. The farmers of the future will have beautiful lawns planted with vegetation as a matter of business. In such homes the family circle will remain unbroken. It is the unattractive home the farmers' children leave. A happy home circle should be more to the farmer than all the money in the world. At the same time he has the added satisfaction of increased wealth and standing in the community brought about by proper landscape gardening.—(Cornell Ex. St. B. 161, 205.)

Planting the Home Grounds.—The trouble with home grounds is not so much that there is too little planting of trees and shrubs, but that this planting is meaningless. Every yard should be a picture. That is, the area should be set off from every other area, and it should have such a character that the observer catches its entire effect and purpose without stopping to analyze its parts. The yard should be one thing, one area, with every feature contributing its part to one strong and homogeneous effect.

The nursery type of planting represents the common front yard. The bushes and trees are scattered promiscuously over the area. Such a yard has no purpose, no central idea. Its only merit is in the fact that trees and shrubs have been planted; and this, to most minds, comprises the essence and sum of the ornamentation of grounds. Every tree and bush is an individual, alone, unattended, disconnected from its environments, and therefore meaningless. Such a yard is only a nursery.

The better plan is a picture. The central idea is the residence, with a warm and open greensward in front of it. The trees and bushes are massed into a framework to give effectiveness to the picture of home and comfort. This style of planting makes a landscape, even though the area be no larger than a parlor. The other style is simply a collection of curious plants. The one has an instant and abiding pictorial effect, which is restful and satisfying; the other simply arouses the curiosity, obscures the residence and divides and distracts the attention.—(Cornell Exp. St. B. 205.)

If the farmer catches the full meaning of these contrasts, he has acquired the first and most important conception in landscape gardening. The conception will grow upon him day by day; and if he is of an observing turn of mind, he will find that this simple lesson will revolutionize his habit of thought respecting the planting of grounds and the beauty of landscapes. He will see that a bush or flower-bed which is no part of any general purpose or design —that is, which does not contribute to the making of a picture— might better never have been planted. A bare and open pasture were better than such a yard, even though it contained the choicest plants of every land. The pasture would at least be plain and restful and unpretentious. It would be nature-like and sweet. But the yard would be full of futile effort and fidget.—(Cornell Exp. St. B. 205.)

Reduced to a single expression, all this means that the greatest artistic value in shrubbery lies in the effect of the mass, and not in the individual shrub. A mass has the greater value because it presents a much greater range and variety of forms, colors, shades and textures, because it has sufficient extent or dimensions to add structural character to a place, and because its features are so continuous and so well blended that the mind is not distracted by incidental and irrelevant ideas.

If a landscape is a picture, it must have a canvas. This canvas is the greensward. Upon this, the artist paints with tree and bush and flower the same as the painter does upon his canvas with brush and pigments. The opportunity for artistic composition and structure is nowhere so great as in the landscape garden because no other art has such a limitless field for the expression of its emotions. There can be no rules for landscape gardening, any more than there can be for painting or sculpture. The operator may be taught how to hold the brush or strike the chisel or plant the tree, but he remains an operator; the art is intellectual and emotional and will not confine itself in precepts.

The making of a good and spacious lawn then is the very first practical consideration in a landscape garden for a country home. This provided, the farmer conceives what is the dominant and central feature in the place, and then throws the entire premises into subordination with this feature. In home grounds this central feature is the house. To scatter trees and bushes over the area defeats the fundamental purpose of the place—the purpose to make every part of the grounds lead up to the home and to accentuate its homelikeness. Keep the center of the place open. Plant the borders. Avoid all disconnected, cheap, patchy, and curious effects. It is not enough that the bushes be planted in masses. They must be kept in masses by letting them grow freely in a natural manner. The pruning-knife is the most inveterate enemy of shrubbery.—(Cornell Exp. St. B. 205.)

The use of flowers and bright foliage and striking forms of vegetation is not discouraged, but these things are never primary considerations in a good place. The structural elements of the place are designed first. The flanking and bordering masses are then planted. Finally, the flowers and accessories are put in, in just the same way that a house is painted after it is built. Flowers appear to best advantage when seen against a background of foliage, and they are then, also, an integral part of the picture. The flower garden, as such, should be at the rear or side of a place, the same as all other strictly personal appurtenances are; but flowers and bright leaves may be freely scattered along the borders and near the foliage masses.

What kinds of shrubs and flowers shall be planted is a wholly secondary and largely personal consideration. Be sure that the main plantings are made up of hardy and vigorous species, and have lots of them. Then get the things liked best. Some like bull-thistles, lilacs, hollyhocks, burdocks, rhubarb, dogwoods, spireas, elders and such careless things. But others have better tastes. There is endless merit in the choice of species, but the point to emphasize is that the arrangement or disposition of the plants is far more important than the kinds.

It should be said that the appreciation of foliage effects in the landscape is a higher type of feeling than the desire for mere color. Flowers are transitory, but foliage and plant forms are abiding. The common roses have very little value for landscape planting, because the foliage and habit of the rose bush are not attractive, the leaves are inveterately attacked by bugs, and the blossoms are fleeting. Some of the wild roses and the Japanese *Rosa rugosa,* however, have distinct merit for mass effects. Wild bushes are nearly always attractive when planted in borders and groups. They improve in appearance under cultivation, because they are given a better chance to grow. In wild nature, there is such a fierce struggle for existence that plants usually grow to few or single stems and they are sparse and scraggly in form; but once given all the room they want and a good soil, and they become luxurious, full and comely. In most home grounds the body of the planting may be very effectively made by the use of bushes taken from adjacent woods and fields. The masses may then be enlivened by the addition here and there of cultivated bushes, and the planting of flowers and herbs about the borders. It is not essential that one know the names of these wild bushes, although a knowledge of their botanical features will add greatly to the pleasure of growing them. Neither will they look common when transferred to the lawn. There are very few people who know even the commonest wild bushes intimately, and the bushes change so much in looks when removed to rich grounds that few people recognize them.—(Cornell E. S. B. 205.)

To make a group, dig up the entire area. Never set the bushes in holes dug in the sod. Spade up the ground, set the bushes thick, hoe them, and then let them go. If you do not like the bare earth between them, sow in the seeds of hardy annual flowers, like phlox, petunia, alyssum and pinks. The person who plants his shrubs in holes in the sward does not seriously mean to make any foliage mass, and it is likely that he does not know what relation the border-mass has to artistic planting. Planting the bushes thick is for quick effect. It is an easy matter to thin the plantation if it becomes too thick. Generally plant all common bushes as close as two feet apart each way, especially if most of them come from the fields instead of the nursery.

If one has no area which he can make into a lawn and upon which he can plant verdurous masses, what then may he do? Even then there may be opportunity for a little neat and artistic planting. Even if one lives in a rented house, he may bring in a bush or an herb from the woods and paint a picture with it. Plant it in the corner by the steps, in front of the porch, at the corner of the house, almost anywhere except in the center of the lawn. Make the ground rich, secure a strong root and plant it with care; then wait. The little clump will not only have a beauty and interest of its own, but will add immensely to the furniture of the yard. About its base one may plant stray bulbs of glowing tulips or dainty snowdrops and lilies-of-the-valley; and these may be followed with pansies and phlox and other simple folk. Very soon one finds himself deeply interested in these random and detached pictures, and almost before he is aware he finds that he has rounded off the corners of the house, made snug little arbors of wild grapes and clematis, covered the rear fence and the outhouse with actinidia and bitter-sweet, and has thrown in dashes of color with hollyhocks, cannas and lilies, and has tied the foundations of the buildings to the greensward by low strands of vines or deft bits of planting. He soon comes to feel that flowers are most expressive of the best emotions when they are daintily dropped in here and there against a background of foliage. Presently he rebels at the bold, harsh and impudent designs of some of the gardeners, and grows into a pure and subdued love of plant forms and verdure. He may still like the weeping and cut-leaved and party-colored trees of the horticulturist, but he sees that their best effects are to be had when they are planted sparingly, as flowers are, as borders or promontories of the structural masses.

It all amounts to this, that the best planting, like the best painting and the best music, is possible only with the best and tenderest feeling and the closest living with nature. One's place grows to be a reflection of himself, changing as he changes, and expressing his life and sympathies to the last. It is this partnership of nature and art which makes the farmer's children in after years always think lovingly of the old place as "Home, Sweet Home."—(Cornell E. S. B. 205.)

CHOOSING ORNAMENTAL SHRUBS AND FLOWERS.

Choose regardless of any slighting remarks the good old species which have stood the test of a thousand years and which today furnish the root and basis for all the horticultural freak varieties that bring fancy prices and which deteriorate to nothing after a year or so of crowded and profusely vulgar bloom. Sometimes there is no description, except the color of the flowers given, and one might guess at the wrong one, so for convenience sake it will be best to list the best shrubs for the door yard in several groups according to classification and refinement.

It is well to repeat that in planting one should always leave a wide open lawn; plant the outer border heavily with a mass of rather dense shrubs thereby attaining a sort of privacy on the grounds and maintaining a definite form and outline to the property. Plant also with a more refined class of shrubs against the foundations and corners of the building and cover the front porch with a few good clean vines.

In the border plantation use the less refined plants farthest away from the approach; use a variety of kinds, but enough of one type in a place to produce a definite effect of light, shade, color, flower, or fruit. There are many shrubs which are good all the season through. The flowers are by no means the only beautiful things in nature. There are the bright leaves in spring and fall berries some of which hang on all winter. Others are evergreen or semi-green and in many cases the fall color of leaves is astounding. There are many different shades of green in leaves, which when mixed are exceedingly interesting, while variations in bark color and type are as good as a collection of museum curios.

Shrubs.—Shrubs of the latitude of New York fall into three classes in regard to height: First, low dwarf shrubs in full development growing seldom over 2½ feet high. These should be planted about 2 feet apart. In this class are the holly leaved barberry, dwarf deutzia, Japanese barberry, coral berry and spiræa Anthony waterer. For this class of shrubs where especial refinement is desired, hardy perennials are often substituted. Those suitable for such substitution are German iris, phlox paniculata, peonies, funkia or day lilies, spiræa Jap, or Astilbe Japonica and Adam's needle or Yucca.

The second or medium height shrubs are those which at full development attain approximately 5 to 6 feet and are usually planted about 3 to 4 feet apart. This class includes the Weigela roseum, purple leaved barberry, mock orange, golden bell, yellow flowering currant, Japan quince, sweet shrub, Deutzia pride of Rochester, Regal's privet, Van Houtte's spiræas, Japanese spiræa, bridal wreath, snowberry, tall bush cranberry, Japanese snowball, single Japan snowball, withe rod, Ramanan's rose (Jap.), groundsel-tree and sweet pepper bush.

The list of shrubs just mentioned is usually mixed with and backed up by the third classification, which are those plants which when full grown are taller than 6 or 7 feet; but which do not reach the proportion or character of small trees. In the list we have the lilac, large flowering mock orange, five fingered aralia, common barberry, witch hazel, strawberry tree, Amoor's privet, buckthorn, red and black elderberries, smoke tree, arrow wood, wayfaring tree, sheepberry, arbor vitæ (evergreen), red twigged dogwood and hazel.

Small ornamental trees which may be placed singly or in groups of three about 8 feet apart among the shrubs in the border plantation are the red bud, flowering dogwood, staghorn sumac, white birch, maidenhair tree and the smooth sumac.

Certain shrubs are of such a type that they should be used singly, as specimen plants. They are usually set a little out from the main mass of shrubbery into the border which serves as a background to set off the specimen to best advantage. Of such shrubs we have the hardy hydrangea, rose of sharon, spindle tree, white fringe, flowering almond, and hawthorn.

Ornamental Trees.—If the front lawn is small do not attempt to plant trees in it, and especially not exactly in the middle. However, on a wide, spacious lawn nothing is more desirable than a few groups of shade trees or single specimens placed a little to one side of the center line and near that portion of the grounds where shade is needed. Some of the best ornamental shade trees are the American linden, horse chestnut, American elm, tulip tree, hackberry, mossy cupped oak and others, sycamore and maple.—(Ill. E. S. Cir. 135.)

Vines.—House vines are not easily classified, but they may be grouped primarily (1) as for green covers and (2) for floral display. The former would include the ivies, the hedera leading, for, in the North, it does not even bloom and its leaves are evergreen. The Japanese ivy is of the same close-clinging type (although its method of holding fast by tendril discs is far different from that of by true roots in the English ivy), but has deciduous foliage of a much more sprightly tone of green. As to the flowers, only the bees usually know of them, and on from the middle of July, the results of the blossoming are obtaining in the form of clusters of blue-black spherical grape-like berries that, hanging near the naked wall after the leaves have gone, give an earnest of the fruitfulness of the green cover in the summer and early autumn. All the colors that appear in the rose in its fleeting summer petals are here conserved and flashed out for weeks in the autumnal foliage. In sheer splendor there is no climbing plant that equals the Japanese ivy when it assumes its October garb. As met with at its best it seems as if the Artist had dipped the giant brush in a harmonious mixture of crimson and gold and touched the walls as an earnest of

Infinite purpose and perfection. The American ivy is likewise a vine grown for its rich festoons of tangled branch-tips and dark "fingered foliage," interspersing the varying tones of green between the earlier and later leaves, while the multitudes of brown flower-buds may redden the way in July, and the liberal supply of wide-spreading berry-clusters in autumn are but incidents in the annual life of the cherished vine.

The pipewort is to be included in this class where the foliage is first and last the leading element and the strangely-constructed even fantastic "pipes" only heighten the interest in the dark-green foliage among which the blossoms hang inconspicuously as objects of floral wonderment.

The hop, while it may be loaded with fruit of its own peculiar making as the season closes, flings out no banner of bright color to catch the eye of passing insect, and therefore in its dark-green dress should stand among those plant covers that gain their place for foliage chiefly. The matrimony vine* brings us to a point in the list where it is not quite so easy to decide, for it hangs full of minute blossoms not seen by the unobserving, but fondly visited by the industrious bees, and in early autumn all may notice the orange-yellow berries like so many minute tomatoes that would need much magnification to show the close resemblance. Besides it is one of the first vines to sound the color note of spring.

If the matrimony vine be admitted, then it is only a step to the trumpet creeper, with its flowers lasting only for a short time in midsummer, and serving to attract attention to the overflowing richness of the loose foliage as it falls as a spray from the eaves. It is the sway and movement of the free vine tips, the rich texture and deep color of the trumpet creeper as a climber that satisfies, and not the scattered glove-finger corollas that only accentuate the qualities of the verdure that strives to envelop them.

The wistarias may become the bridge over which to pass from the foliage to the floral side of our groups of subjects. These lofty, aspiring climbers have a phase in their annual cycle when the blossoms are, above all else, the most conspicuous. In May and before, the compound leaves have scarcely thought of the growing season, the flower buds have opened, and out of them come the giant clusters like skillfully arranged pea blossoms in a leafless pendant of surprising length, and hung in such profusion that it would seem as if the gorgeous, exhausting work was overdone and further growth of the ambitious vine would be impossible. But, before this solicitude has taken root the leaves unfold, and shortly the large rope-like stems are covered with foliage half formed and of a light, warm and tender hue.

Along with such strong bloomers as the wistaria must be arranged roses, although the sequence of foliage and floral advents is not the same. The colors in the rose are higher, as is red or crimson above the lilac of the wistaria, and, as if thinking it would be too strong a change from bare canes to the brilliancy of the "Baltimore belle" or "crimson rambler" in full bloom, the rose first weaves a tapestry of fresh green upon the trellis, and then when all nature is in full leaf it comes forth with its display of blooms as a welcome to the rare and perfect June. The individual flower is the acme of beauty in form, texture and color, while the background of delicate perfume only adds to that which already seemed perfection. No wonder that the lovers of the beautiful in nature have agreed so generally in crowning the rose as queen.

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* For illustration, see page 483.

The foliage of the rose is ordinarily sparse, and for purposes of piazza screens needs to be supplemented by that of some other climber in harmony with it. This cannot be that of the wistaria or trumpet creeper, or yet of the pipe-vine, for these are all of the coarse, masculine form of plant covers; but instead something that is both delicate and substantial as the honeysuckle, with its fine, leafy stems, producing a well-disposed screen with flowers that are inconspicuous as compared with roses, and keep coming all the season through with a fragrance of peculiar sweetness at evening when the piazza is most apt to be the outside resting place for the family. The honeysuckles are more closely related to the foliage twiners than the clematises, for in the latter the leaves are light in tone of green, airy in form, and unless the slender stems are numerous, the shade is scant. Certain species of the clematis group are among the most conspicuous bloomers on the whole list of climbing plants, and one only needs to refer to the Jackman type in support of this. The purple and blue, and even the white blooms are truly surprising for their size, but less can be said of the fragrance. Along with the roses such climbers need to be placed at the head of the list of vines with conspicuous flowers, and without which they would lose a large part of their attractiveness and usefulness as ornamental live covers for our homes. The *Clematis paniculata* type, which includes our native Virgin's bower,* has the more modest bloom, but weaves the small flowers into such a showy, fluffy blanket, that the whole mass becomes conspicuously beautiful. The plant is of the feminine type of climber, full of grace and quiet beauty. It is with this clematis that the ornamental nature of the fruit is brought to the front. For weeks in autumn its feathery plumes make a display of refined texture and tint that is one of the most attractive features of the vine. There is no other climber that can equal it, not even the "wax-work," with its clusters of orange-yellow fruits, the handsome berries of the matrimony vine or of the honeysuckle.

There are many farm buildings that may have an added touch of beauty through a live cover. Brick barns are in mind with the walls covered beautifully with ivy, and at practically no expense. The shed where stands the grindstone may be made more attractive by a grape-vine or a honeysuckle. The dairy-house at the spring, or the stone wall near the stable might well be draped with green, and add neatness to the scene. It is best not to forget the beautiful when one passes to the rear of the house; it would be better if the dwelling were front all around.

No matter what plants are to be grown, they demand a good preparation of the soil. Many think it is only a small matter to

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*** For illustration, see page 501.**

"stick out a vine," and it can be done at any odd time and in any sort of a way, and here is where the greatest number of failures occur. If the same vine with the same care (or lack of it) had been set in the field or along the fence, it would have been more apt to grow. The side of a wall is the place of all others that is not already prepared to receive a plant that is to climb, and this is emphatically true with new walls where the material, instead of being earth, is a mixture of mortar and brick, ashes, lath and plaster, in short, the refuse of the building not yet subdued by time and enriched by the overgrowth of grass. Remove all such rubbish by the bushel and in its place supply a mixture of rich soil and good manure. Into this favorable soil place the well-rooted vine as carefully as one would set a young orchard or vineyard plant. The plant is peculiarly exposed and needs a guard placed around it, or it will get pulled up, trodden down or otherwise destroyed. Water is occasionally needed, and the stems sometimes require aid in getting hold of the wall, if an ivy, or the support that must be provided for it while the vine is small, weak and tender.

The nurserymen carry a full line of climbing plants, and there is no excuse for any one being long deprived of any vine for which he or she has a peculiar fondness. Nearly all are grown with comparative ease, and some increase almost too rapidly after they become established. The honeysuckle propagates abundantly and the matrimony vine needs to be kept from spreading along the ground. When once a vine is started, as a rule, the hoe, as well as the pruning knife, are needed to control it, which leads naturally to the consideration of the care of vining plants. It only need be said that any vigorous plant, so situated that its climbing habit is humored, easily gets beyond the bounds that the owner has provided for it. A Japanese ivy, or other quick grower, may weave a live curtain to a spare bedroom window when inhospitality or other cause has kept the guest chamber closed, or ply a lacework to a shutter before the month at the seashore or mountains is past. But these accidents, or rather incidents of growth, will not obtain with those who give a weekly or almost daily glance at the progress the climbers are making. They will get too thick in some places, and if left untouched, a "bunchy" effect is produced, or possibly nature will clear it all away when in some gale the unkempt vine is torn from its moorings and cast toward the ground, when at last the knife, too long withheld, is applied to remove the unsightliness while the mother bird mournfully and noisily contends for her rights in the debris where her household lies in ruin. He who plants a vine sets for himself the task of watching its growth, which the true lover of plants will naturally enjoy. A good rampant vine, and none other serves its purpose as a screen and cover, will no more take care of itself than the morals and manners of a wide-awake and well-equipped boy.

The ivies will need as a rule to be limited to the walls of brick or stone. If covering a brick chimney, there will be some effort made to keep them from the woodwork, where they would hold water, accumulate dirt and damage the paint. The coarser vines, like the wistarias and trumpet creepers do best when guided in their upward and lateral growth by strong wire cords firmly fastened to permanent supports. In this way the vine may be taken up to the second or third story and there be led out horizontally as desired. Such vines need an annual pruning, and when of the desired size this should be done thoroughly or else the festoons become top-heavy and unsatisfactory. When trained for a piazza screen, strong posts may be set a foot or so away from the eaves, and, with a cross-bar or two, a skeleton is ready for the vines and the porch is free. The sprays of the wistaria thus hang better than when the vine is fastened to the roof, and the woodwork is preserved in better form, besides there is none of the trouble of laying down the vines when the painters come—a class of people who are not partial to live covers and act accordingly.

The finer vines, as roses, clematis and even honeysuckles, which are trained to the wire netting both perpendicularly and latterly may receive the needed care of the one in charge, from time to time, directly from the piazza, supplemented with a severe pruning in the fall or spring as circumstances of age and growth suggest.

An occasional turning on of the hose, if it is available, from the piazza side, as the season advances, is useful in giving the vines a clean appearance. Sometimes plant-lice appear and such a spraying with the hose is helpfull in removing them and other pests. Such a washing may be only an extension of the area of cleansing when the floor and sides of the porch receive their occasional or stated scrubbing.

From a somewhat extended correspondence with the various Experiment Station Botanists and Horticulturists, the following list of vining plants were developed. The number of times a plant has been favorably mentioned is shown by the figure following the name:

1. American ivy (*Parthenocissus quinquefolia* L.), 20.
2. Climbing roses (*Rosa* sp.), 14.
3. Trumpet creeper (*Tecoma radicans* Juss.), 13.
4. Honeysuckles (*Lonicera* sp.), 13.
5. Chinese wistaria (*Wistaria Chinensis* DC.), 12.
6. Japenese ivy (*Parthenocissus tricuspidata* Seib. & Zucc.),10.
7. Virgin's bower (*Clematis Virginiana* L.), 9.
8. False Bitter-sweet (*Celastrus scandens* L.), 8.
9. Jackman's clematis (*Clematis Jackmani* Jack.), 7.
10. *Clematis paniculata* Thumb., 6.
11. Clematis, 5.
12. Dutchman's pipe (*Aristolochia macrophylla* Lam.), 5.
13. English ivy (*Hedera Helix* L.), 4.
14. Wild grape (*Vitis* sp.), 4.
15. Aristolochia, 4.
16. Akebia (*Akebia quinita* Decne.), 4
17. Passiflora, 3.
18. Hop (*Humulus Lupulus* L.), 3.
19. Bignonia, 3.

20. Matrimony vine (*Lycium barbarum* L.), 2.
21. *Clematis ligusticifolia* Nutt., 2.
22. Moonseed (*Menispermum Canadense* L.), 2.
23. Silk vine (*Periploca grœca* L.), 2.
24. *Solanum jasminoides* Paxt., 2.
25. Ipomœa, 2.
26. Jessamine, 2.
27. Chili jessamine, 2.—(N. J. E. S. B. 144.)

Flowers.—The main planting of any place should be of trees and shrubs. Flowers should be used as decorations. They may be thrown in freely about the borders of the place, not in beds in the center of the lawn. They show off better when seen against a background: this background may be foliage, a building, a rock, or a fence.

Where to plant flowers is really more important than what to plant. In front of bushes, in the corner by the steps, against the foundation of the residence or outhouse, along a fence or a walk,—these are places for flowers. A single petunia plant against a background of foliage is worth a dozen similar plants in the center of the lawn. Too many flowers make a place over-gaudy. Too much paint may spoil the effect of a good building. The decoration of a yard, as of a house, should be dainty.

The open-centered yard may be a picture: the promiscuously planted yard may be a nursery or a forest. A little color scattered in here and there puts the finish to the picture. A dash of color gives spirit and character to the brook or pond, to the ledge of rocks, to the old stump, or to the pile of rubbish.

A flower garden.—A person may want a flower garden. It is not primarily a question of decoration of the yard but of growing flowers for flowers' sake. It is not the furnishing of a house, but the collecting of interesting and beautiful furniture. The flower garden, therefore, should be at one side of the residence or at the rear; for it is not allowable to spoil a good lawn even with flowers. The size of the garden and the things to be grown in it must be determined by the likes of the person and the amount of time and land at his disposal; but a good small garden is much more satisfactory than a poor large garden. Prepare the land thoroughly, fertilize it, resolve to take care of it, select the kind of plants you like; then go ahead.

Plants for screens.—Many annual plants make effective screens, and covers for unsightly places. Wild cucumber (or echinocystis), cobea, and sweet peas may be used to decorate the tennis screen or the chicken-yard fence. The alley fence, the smoke-house, the children's play-house, may be screened with morning glories, flowering beans, and other twiners and climbers. The windows may be screened and decorated by vines grown either in the ground or in window-boxes.

Efficient screens can be made of many strong-growing and large-leaved plants, of which castor beans, sunflowers, cannas, tobacco and other nicotianas, striped or Japanese corn, are the chief.

How to grow annuals.—The annual flowers of the seedsmen are those which give their best bloom in the very year in which the seeds are sown. The true annuals are those plants which complete their entire life-cycle in one season. Some of the so-called annual flowers will continue to bloom the second and third years, but the bloom is so poor and sparse after the first season that it does not pay to keep them.

Most annuals will bloom in the North if the seeds are sown in the open ground when the weather becomes thoroughly settled. But there are some kinds, as cosmos and moon-flowers, for which the season is commonly too short to give good bloom. These kinds may be started early in the house or in hotbeds; and similar treatment may be given any plants of which it is desired to secure blooms before the normal time.

Prepare the ground thoroughly and deep. Annuals must make a quick growth. See that the soil contains enough humus or vegetable mold to make it rich and enable it to hold moisture. If the ground is not naturally rich, spade in well-rotted manure or mold from the woods. A little commercial fertilizer may help in starting off the plants quickly. Prepare the land as early in spring as it is in fit condition, and prevent evaporation by keeping the surface loose by means of raking.

If the flowers are to be grown about the edges of the lawn, make sure that the grass roots do not run underneath them and rob them of food and moisture. It is well to run a sharp spade deep into the ground about the edges of the bed every two or three weeks for the purpose of cutting off any grass roots which may have run into the bed. If beds are made in the turf, see that they are three feet or more wide, so that the grass roots will not undermine them. Against the shrub borders, this precaution may not be necessary. In fact, it is desirable that the flowers fill all the space between the overhanging branches and the sod.

Sow the seeds freely. Many will not germinate. Even if they do all germinate, the combined strength of the rising plantlets will break the crust on the hard soils; and in the thinning which follows, only strong and promising plants are allowed to remain. Better effects are also often secured when the colors are in masses, especially if the flowers are thrown into the bays of heavy shrub borders.

Plants continue to bloom for a longer period if they are not allowed to produce seeds. The flowers should be picked, if possible, as soon as they begin to fade.

The kinds of annuals.—In the selection of the kinds of annuals, one's personal preference must be the guide. Yet there are some groups which may be considered to be standard or general-purpose plants. They are easily grown almost anywhere and are sure to give satisfaction. The remaining plants are mostly such as have secondary value, or are adapted to particular purposes or uses.

The groups which make the strongest appeal as staple or general-purpose types are the following: Petunias, phloxes, pinks or dianthuses, larkspurs or delphiniums, calliopsis or cereopsis, pot mari-

gold or calendula, bachelor's button or Centaurea Cyanus, clarkias, zinnias, marigolds or tagetes, collinsias, gilias, California poppies or eschscholtzias, verbenas, poppies, China asters, sweet peas, nemophilas, portulaccas, silenes, candytufts or iberis, alyssum, stocks or matthiolas, morning-glories, nasturtiums or tropaeolums.

Annual flowers possess a great advantage over perennials in the fact that they appeal strongly to the desire for experiment. The seeds are sown every year, and there is sufficient element of uncertainty in the results to make the effort interesting; and new combinations can be tried each year.

Do not cut the old stalks down in the fall. They will stand in the snow all through the winter, and remind you of the bursting summer time and the long-ripening fall; and the snow-birds will enjoy them.—(Cornell E. S. B. 161; Ill. Exp. St. B. 135.)

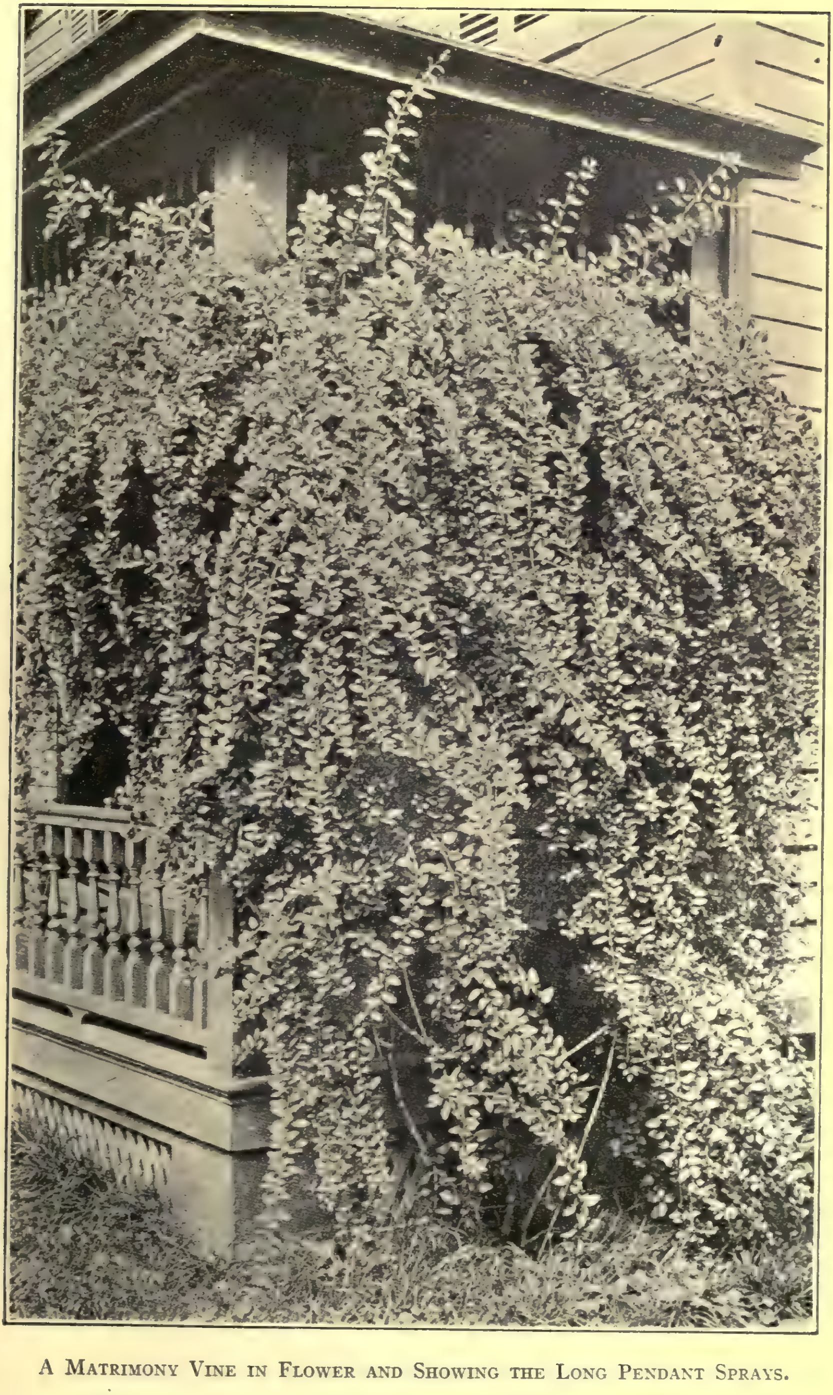
Roses.—Last but not least, set aside a little back corner in a sunny wind-protected place at the end of a garden wall for a rose garden. Put here a little rustic seat and plant, in the North, some of the following kinds about 2½ to 3½ feet apart; *Alfred Colomb,* reddish crimson; *Anna de Diesbach,* silver pink; *Baron de Bonstettin,* dark crimson; *Dinsmore,* dark crimson; *Clio,* pale pink; *Earl of Dufferin,* purplish crimson; *Eugene Furst,* velvety crimson shaded maroon; *Frau Karl Druschki,* white, a continuous bloomer; *General Jacqueminot,* scarlet crimson; *John Hopper,* rosy pink; *Jules Margottin,* rose pink; *Mount Carmel,* deep reddish pink; *Oakmont,* silvery pink, very free flowering; *Paeonia,* bright crimson.

The following is a list of good roses for the South and Southwest: *American Beauty*—(Hybrid Tea). Color, rosy crimson; a good bloomer, with fine buds on long stems; has done well for several years in succession and is evidently one of the best roses for our climate. *Bougere*—(Tea); color, pink, with a shade of bronze. *Bon Silene*—(Tea); color, dark crimson; makes fine buds. *Bride*—(Tea); color, white; a good bloomer. *Catherine Mermet*—(Tea): color, light pink; one of the best. *Duchess of Albany*—(Hybrid Tea); sometimes called the Red La France; color, a deep, rich pink, with exquisite buds. *Gen. Jacqueminot*—(Hybrid Perpetual); color, dark red; a profuse bloomer and good rose. *Gen. Lee*—(Tea); color, apricot yellow. *Hermosa*—(Bourbon); an old variety; color, pink; medium sized flowers; very hardy. *Kaiserin Augusta Victoria*—(Hybrid Tea); color, white; a profuse bloomer, good grower and one of the best varieties to plant; has done well for a number of years. *La France*—(Hybrid Tea); color, pink; well known as a constant bloomer; shows some tendency to suffer from heat but with sufficient water does well. *Madame Testout*—(Hybrid Tea); color, pink; a reliable rose. *Maman Cochet*—(Tea); color, pink; a good grower, producing the most beautiful, well-shaped, long buds on long stalks. *Safrano*—(Tea); color, apricot-yellow; one of the few yellow teas that do well; needs protection in a very cold winter. *Souvenir de Wooton*—(Hybrid Tea); color, crimson. *Sunset*—(Tea); color, golden yellow, tinged with copper and crimson; not always a very strong grower but blooms profusely; should be protected if the winter is unusually severe. *White La France*—(Hybrid Tea); called also *Augustine Guinoiseau;* possesses the good qualities of the La France. *White Malmaison*—(Bourbon); color, white with touch of light blush; a strong grower and profuse bloomer. In buying roses be sure that they are grown upon their own roots—not grafted.—(Others consulted in this article: Ill. E. S. B. 135; N. Mex. E. S. B. 40; Ont. E. S. R. 1910.)

Business Suggestions.—Before planting the home grounds make up a list of what you are going to need. Send this list for quoted prices to several concerns and accept the best all-round offer. Get your neighbor to do the same; get out a big list, get your plants cheaper and save on the freight. Fix up the place. It shows proper respect for the wife and daughters who have a keen natural taste for beauty adornment and sentimental results. A beautiful lawn and other grounds meet and realize a woman's natural sense of refinement. Besides other considerations home embellishment is a good business investment. A postal addressed to any one of the reliable houses, of which the following are a few, will bring their nursery catalogue to the farmhouse free of charge: Ellwanger & Barry, Rochester, New York; Swain, Nelson & Sons Co., Chicago; Biltmore Nurseries, Biltmore, North Carolina; Wm. H. Moon, Morrisville, Pa.; Thomas Meehan, Germantown, Pa.; Storrs & Harrison Co., Painesville, Ohio; The Phœnix Nursery, Bloomington, Illinois; D. Hill, Evergreen Specialist, Dundee, Illinois; Peterson Nursery Co., Chicago; Elliott Nursery Co., Pittsburgh, Pa.—(Ill. E. S. B. 135.)

Use of Plants About a Dwelling.—Annual plants which have a suitable habit of growth and adequate foliage may be made to do duty about the dwelling and upon the grounds in the place of the more appropriate shrubs and perennials. The one great drawback to which such annual plantations are subjected is their yearly destruction by the first hard frosts of the season. Annual plants, such as cosmos, castor bean, sunflower, aster, zinnia, and flowering sage, may all be made to serve as substitutes for shrubbery plantations until the shrubs themselves have grown to sufficient size to command the situation.

Tall-growing, broad-leaved plants, like the castor bean, can be used with advantage as screens for driveways or walks by placing a mass of the plants in the bay of the walk or drive. The tall-growing plants of this description when massed against buildings, fences, or other obtrusive objects serve as attractive and efficient temporary screens. Lower-growing plants when massed in borders along the boundary of the place, with taller-growing annuals or shrubs as a background, are more effective than when used in beds at the front or side of a dwelling. In fact, the formal bed, either in the shape of an oval, circle, or star, in the center of a greensward, is generally more obtrusive than pleasing. The next best place for the annuals after the border is in masses about the foundation of a building; and if vines of a temporary nature are desired, some of the rapid-growing sorts, such as Cobæa scandens, the moonflower, morning-glory, or cypress vine, may be appropriately used for training over fences or walls, or about porches.



A Matrimony Vine in Flower and Showing the Long Pendant Sprays.

When annual plants are desired for the bloom which they produce for use as cut flowers, the best disposition of them is to plant them in an area set apart for a flower garden or to devote a portion of the vegetable garden proper to the purpose. When grown for cut bloom merely, the most satisfactory and economical plan is to plant them in long rows, with ample space both between the rows and the individuals in the row. Unless the plants are given sufficient room for full development the flowers which they produce will be inferior in size and form. To secure the best results from plants to be used in this way rich soil, ample space, and good culture are essential. While it is advantageous to sow the seed thickly at planting time in order to insure a good stand of plants, it is equally desirable to have the plants thoroughly thinned so as to provide ample space for their full development.

If the flower garden is a distinct feature of the place and its mission is to furnish an attractive retreat, as well as cut flowers, its general plan may be more pretentious; the straight rows may give place to irregular groups or masses, or even to formal beds and designs, so long as these are not made the leading feature in the general adornment of the place. In fact, curved pathways in the flower garden allow an opportunity for demonstrating the fitness of certain plants for special purposes. The bays of the curves can be filled with tall-growing, dense-foliaged plants for the purpose of hiding the beds or groups which lie farther on. Curved walks are more pleasing than straight ones, and lend themselves more kindly to the needs of the different classes of plants which find a place in the home flower garden. If the flower garden is to be a permanent feature of the adornment of a place, the walks may be arranged to conform to the contour of the land, or if level may be given some geometrical character or design and made permanent by the use of gravel and grass borders.

If a fixed design is to be adopted, the soil in various areas of the garden may be modified by the addition of sand, muck, or clay, and by the use of plant foods to suit these particular areas to the needs of special plants. Those which enjoy a dry, sandy soil can be provided for, while those which thrive best in a heavy soil can also be accommodated. If, on the other hand, a less formal and fixed character in the garden seems desirable, the whole area may be annually spaded or plowed up, the walks given a new course, and the general scheme of planting changed. Such an arrangement will give variety and novelty to the garden, and for most purposes will prove quite as successful as the more formal arrangement. During wet periods, unless the soil is of a sandy character, the lack of graveled walks will prove a disadvantage.—(F. B. 195.)

Plants and Flowers in Decoration.—Flowers and plants may be used when pictures and bric-a-brac are difficult to secure, and they will be the one feature of greatest interest. Without expense, especially in rural localities, they may be made to add to the home a touch of harmony which is easily lent by the living lines and good colors. Wild asters, wild carrot, and goldenrod in the fall, with the wealth of blossoms in spring, may be much enjoyed for decoration by those who live near them. Display them in the free, open manner in which they grow. This will not admit of bunching them and tying tightly with a string, nor often of placing a variety of kinds in one bouquet. Nasturtiums are beautiful and so are sweet peas, but together in the same vase their form and color are not satisfying. Garlands of flowers and set pieces are conventional forms not often used, and are superseded by the simplicity of single colors and by grouping blossoms of but one kind. Perhaps we may believe that every flower has a message which should not be interrupted by the too close presence of other flowers, each with its own message.

The attractiveness of flowers in decoration is governed to a large extent by the vase in which they are placed, and by other objects near them. The vase therefore has so much to do with the completing of the flower picture that it should not be selected without considering the use to which it is to be placed, the size of the flowers, the length of stem, the color. Neither should the vase be the central figure and attract more attention than the flowers.

A clear glass tumbler of graceful shape is often more appropriate for flowers than an expensive vase with excrescences and bright rivaling colors on its face. A vase that can stand alone, with graceful form that does not interfere with its use, and colored to harmonize with flowers, is a suitable one for these treasures in decoration, no matter how little it costs. A plain tall celery dish is better than a gilded gewgaw flashy vase.

It is better to have a few good plants than many indifferent ones. They should not be scattered about the house, especially not on the floor where they are likely to be in the way. A neat and compact window-box adds a touch of color and cheer to the living-room and kitchen and also makes the house attractive to the passer-by.—(Cornell F. R. C., B. 2.)

Directions for Making Window Gardens.—Procure a 3 or 4 inch pot for each lot of seed to be planted and some rich, sandy soil from the florist's or from the garden. Place over the hole in the bottom of the pot a small piece of broken crockery, the concave side down, and fill the pot to within one-fourth inch of the top with soil, gently pressing this down with the bottom of another pot so as to make the surface perfectly smooth and level, though not enough to make it hard. Large seeds like those of the nasturtium should simply be pressed into the soil about one-half inch deep and the soil drawn together over them with the thumb and finger. Those like the candytuft and snapdragon should be evenly spread over the surface and covered about one-eighth of an inch deep with fine soil carefully sprinkled over the surface so as to cover them evenly. The very small seeds should be thoroughly mixed with ten times their bulk of dry soil, and then the mixture scattered as evenly as possible over the surface in the pot. Cover the seed lightly, using not more than three or four times as much fine dry earth as was mixed with the seed; sprinkle it over the surface as evenly as possible. In all cases, after planting the seed the surface of the soil should be made smooth and even by pressing it down gently with the bottom of another pot; carefully avoid pressing it so heavily as to make the surface hard.

Set the pot in a dish containing water enough to come to within an inch of the top of the pot and let it stand from one-half minute to two minutes, or long enough so that the soil near the edge of the pot will be moistened, but not so that it will be wet. Cover the pot with a bit of clean glass and let it stand in a warm, light place about forty-eight hours; then lift the glass, place on the edge of the pot a burnt match, and replace the glass. About three days later substitute a lead pencil for the match, and after three days more remove the glass altogether. During this time, if the soil seems dry, immerse the pot up to within an inch of the top in tepid water until the soil near the edge of the pot is moist. The object of the glass is to prevent the soil from drying out; that of the match and pencil to hold up the glass to admit air to prevent the plants from becoming "drawn" or spindling from want of air and light. The time when the changes should be made will be determined by conditions and can not be stated for all cases. They may not be needed as early as suggested, or it may be necessary to make them sooner. This can only be determined by the appearance of the plants. The match is not needed at all until the plants begin to come up, and the changes should be made so as to prevent the plants from becoming more than three to five times as high as wide.

When the plants are one-eighth to one-fourth of an inch high they should be thinned out so as to leave from 25 to 36 of the smallest growing plants, like lobelia, and 1 to 9 of the larger ones to the square inch, and after they have recovered from this it will be safe to water them by pouring water on the surface instead of dipping the pots in water. When the plants are from one-half to 1 inch tall they should be transferred to the pots in which they are to bloom; 6 or 7 inch pots are best for this purpose. One to three snapdragon, nasturtium, or petunia plants are sufficient for a pot of such a size, but from 5 to 20 candytuft, sweet alyssum, lobelia, ageratum, or mignonette plants can be used.

Many will prefer to use window boxes, and they may be very effectively filled with plants raised from the seeds of this collection. They should be not less than 4 nor more than 10 inches deep. Half-inch holes 6 inches apart should be bored in the front side, close to the bottom, or in the bottom itself, and there should be at least an inch of broken crocks placed in the box before the earth is put in. In our dry climate such boxes need a great deal of water, and except in continued dark or rainy weather this should be given every day.

If time is more abundant than money and it is necessary to use the least possible amount of cash, tin cans or wooden boxes can be used in place of pots. If cans are used, holes about half the size of a lead pencil and 2 inches apart should be punched around the can as close as possible to the bottom, and into the bottom of the can broken crocks with the concave side down should be placed to a depth of one-half to 1 inch before the soil is put in.

Soil can be secured from the nearest vacant lot that is not covered with coal ashes or rubbish. If a bit of this when placed in the mouth dissolves and melts away without leaving any grit or if when wet and rubbed in the hand it forms a slippery, sticky mud, it is too clayey and sand should be added. This can be procured from the vicinity of buildings where masons are at work. It will require one part of sand to from four to ten of soil; the more distinctly clayey the soil the greater should be the proportion of sand added.

The soil will need enriching, and for this purpose thoroughly rotted stable manure is best; but if this can not be obtained, some fresh manure can be secured from the streets, if need be, or from a cow or horse stable, but it is not well to use that which contains a great deal of sawdust, straw, or other coarse bedding. Dry it thoroughly until it can be crumbled into powder easily; then crumble it up and thoroughly mix it with the soil at the rate of one part of manure to from two to six of soil. This fining of manure by drying and rubbing and the even mixing with the soil are very important. Some of the finest mignonette the writer has ever seen was grown in a gallon tin can in soil made as suggested above.

If boxes are used in place of the larger pots, they should have a series of one-half inch holes, from 3 to 5 inches apart, in the sides close to the bottom, and a layer of broken crocks at least an inch deep should be placed in the bottom before the soil is put in.

Flowering Plants for Window Gardens.—The following varieties of annual flowering plants are specially suitable for window gardens:

Ageratum.—A compact-growing, hardy plant, about 1 foot in height, and producing a constant succession of white, light blue, or purple flowers.

Aster.—Although these plants are more easily grown in the open ground than in pots or boxes and their season of bloom is short, we have seen fine specimens both in pots and in window boxes, and they are so well known and popular that they have been included in the collection.

Cacalia.—A slender, graceful plant, a persistent bloomer, growing about 16 inches high and bearing tassel-shaped, bright, orange-colored flowers.

Calendula.—Rather coarse plants, growing from 10 to 14 inches tall and producing large yellow flowers, well known to many under the old-fashioned name of marigold.

Candytuft.—Hardy, easily grown plants, 6 to 16 inches high. The clusters of white or purple flowers are produced abundantly and through a long season. The plants flower freely when grown in pots and do well in window boxes.

California Poppy.—The young plants of the California poppy (also known as *eschscholtzia*) have very long, narrow leaves and slender stems and are very sensitive to sun or even a slight overwatering. They do best in bright sunshine. These plants are open trailers, 12 to 20 inches across, and are persistent though not abundant bloomers.

Chinese Pink.—The young plants of the Chinese pink are weak, but when once established are quite hardy. These plants grow about 10 inches high and are very persistent bloomers, and the flowers are of very brilliant color.

Dianthus.—A brilliant-colored garden pink. While not easily grown in pots or window boxes it is so brilliant and attractive as to warrant the effort.

Helichrysum (*Eternal Flower*).—These plants sometimes grow fairly well in boxes, and when they do, the persistence and brilliant coloring of the flowers make them a valuable addition.

Lobelia.—The lobelia is a slender-stemmed, delicately graceful plant, bearing small, beautiful blue flowers, and is one of the most desirable plants for window boxes because of its graceful habit of growth and constant bloom. The very small young plants are weak and liable to be killed by overwatering or by too bright sun, but when once established the plants are very abundant and persistent bloomers.

Mignonette.—One of the most fragrant of our common flowers and one that does well either in pots or in window boxes.

Nasturtium.—An excellent plant for window boxes where it often does better than in the garden. Its graceful habit of growth and brilliant-colored, large flowers are very effective. The young plants are much smaller than one would expect from the size of the seed. No manure should be added to the soil for nasturtiums.

Pansy.—The seeds of the pansy germinate freely, but the young plants are of slow and weak growth, very liable to injury from shade or too much sun or heat. When once established, however, they are very persistent bloomers. They do best with a northern exposure. Height 4 to 8 inches.

Petunia.—This plant produces a succession of bright-colored, broad, trumpet-shaped flowers, which give brilliancy to any collection. It makes a good pot plant and is a most desirable one for window boxes. The young plants are small and of slow growth, very liable to injury from overcrowding or overwatering.

Poppy.—The very small and weak young plants are very liable to be killed by crowding or even a slight overwatering, but when once established they are quite hardy. They thrive best in full sunlight. The plants do not remain in flower long. Height 10 to 20 inches.

Snapdragon.—This plant is rather slow to come into bloom, but it is attractive while growing and makes a good background for the other plants of the collection, and when at last it comes into flower it is very brilliant and showy.

Sweet Alyssum.—A low-growing, spreading plant, with small, white, very sweet scented flowers, which are produced in abundance. It might be called a miniature white candytuft. The plant grows well in the house and comes quickly into bloom.

Verbena.—An inexperienced person might think that the seeds of the verbena were simply broken bits of small stems. They are very slow to germinate, and the plants are of slow growth at first, but when once established grow very rapidly and are very abundant and persistent bloomers. The verbena is a trailer, a full-grown plant covering 2 to 6 square feet.

Zinnia.—A strong, rather coarse growing plant, but very hardy and a persistent bloomer. The seeds are slow to germinate and the young plants should be given plenty of room to develop. Height 10 to 24 inches.—(B. P. I. Cir. 433.)

Indoor Flowers in Relation to Health.—Plants purify the air of a living room during the day. They use the poisonous foul gas in the air, and give off oxygen. At night, however, this process is reversed to some extent, light in connection with the leaf green being necessary for the plants to take the impurities from the air. It is essential therefore that this should be watched when flowers are used in the sick room and the living room.—(Cornell F. R-C. B. 5.)

COMMERCIAL FLOWER FARMING.

Fruits, flowers, and vegetables are needed to meet the requirements of life, and these, to be furnished at their best, must be grown for the most part close at hand and produced in such a way that the largest return can be secured from a given area of land with a minimum risk. To accomplish this result it must be practicable to control to a large extent climate, soil, moisture, temperature, and, in a measure, light. The only way this can be done successfully and practically is through the medium of glass houses.

General Plant Growing.—The field of general plant growing probably offers more opportunities than any of the others; that is, opportunities for a greater number of people. In the vicinity of every town or city having a population of from 3,000 to 10,000 there may be found in most cases good openings for the ambitious and progressive farmer who desires to supply a home market with general crops which may be grown partly under glass and partly in a very intensive way out of doors. The demand in towns and cities of this size, of course, is not for any great quantity of any one thing; hence, the necessity for producing a variety, as ornamental plants for use in home yards, plants for cut flowers, vegetables, etc.—a general miscellaneous stock.

In work of this nature it is essential that the location selected be within easy reach of the business limits of the city, for the grower will have to depend largely for his trade on those who may visit his establishment. Such being the case, land must be secured, if practicable, within easy access of those who may wish to visit the place as prospective buyers.

For an ordinary establishment of this nature half an acre of ground is sufficient for a small start. An acre would be better. Due attention must be given to the location with respect to soil, water facilities, and opportunities for securing fuel and other essential things required in general work. In most cases half an acre of ground under such circumstances can be bought for $500. To equip properly a small greenhouse would require another $500. For miscellaneous equipment, including tools, outbuildings, and stock, $200 would be necessary for a start. Thus, there would be invested in the neighborhood of $1,200. If the man himself wished to live at the place, as he should do, it would probably require from $800 to $1,000 for a home. In producing a variety of crops, as indicated above, the gross income from such a place should be at least $1,200 per annum. Practically, all the work on such a place could be done by the owner, with some little assistance from time to time in spring and fall.

The crops handled should be a general assortment of bedding plants, a small collection of ornamentals—such as palms, ferns, etc., which could be sold as pot plants—and carnations, roses, chrysanthemums, etc., for cut flowers during the winter. A considerable portion of this work can be done out of doors, the plan being to have the outdoor crops grown in such a way as to harmonize with the plans for inside work. Of course, a definite system must be followed, and this system will in a measure depend on local conditions. A few hotbeds and cold frames will add materially to the possibilities of such an establishment and will allow the owner to increase his stock considerably, especially of spring-bedding plants, which may be started earlier in the greenhouse and then moved to the frames outside as the season advances.—(Y. B. 1904.)

Cut-Flower Growing.—This is the most profitable field in the growing of plants under glass. It is most profitable for the reason that there is a greater demand for cut flowers than for vegetables, and while the risks in some cases are greater the profits are correspondingly large. The work in this field may be of two kinds—the growing of mixed crops, or specialization with one crop alone.

By mixed crops is meant the growing of three or more crops of flowers, such as roses, carnations, violets, and chrysanthemums. In this field the best openings are to be found near cities with a population of from 10,000 to 50,000. There is always a demand in cities of this size for cut flowers, and this demand is frequently increased if there are any special institutions in or near such cities, such as colleges, universities, etc.

The grower here may either handle his own products or sell direct to dealers in the cities. It is more profitable, if capital can be secured, to handle one's own products. A store in the town or city eliminates the middleman and enables the grower to take not only the profits from the growing of his crops, but the commissions which must be paid for selling the flowers as well. These usually represent about 100 per cent. In other words, the crops which the grower sells to the retailer in the city are sold by the latter at about 100 per cent advance over the prices paid to the grower. Considering the extra expense of store rent, clerk hire, etc., a considerable portion of this profit may just as well be secured by the grower, if he has the business capacity and can manage the details connected with both the city department and the producing department.

Moreover, this field offers opportunities for those who for various reasons can not obtain sufficient ground very near to a city. In other words, flowers such as have been mentioned grown under glass may be shipped with perfect safety from 50 to 300 miles, thus broadening the field of the prospective grower. This makes it practicable to secure land at very reasonable prices; but in addition to this must be considered the extra expense of express and freight rates both in the transportation of the crops produced and in the transportation of the material actually required for the work, such as fuel, manure, etc. Ordinarily, however, many choice locations can be found in the vicinity of a city where half an acre or an acre of ground can be secured at a price of from $250 to $500 per acre. It is not always practicable, however, to secure land as reasonably as this; more often, half an acre of such land will cost $500.

Starting with such an area of land, three houses may be constructed, each at a cost of $1,000. In these may be grown roses, carnations, and violets. In this connection it is necessary to emphasize the fact that these crops can not be successfully grown all in the same house. Each requires a special temperature and special treatment, and hence the necessity for division of labor. With the land costing $500, three houses, $3,000, general equipment, $500, and a home for the grower costing at least $1,000, we have an investment of $5,000. The gross income from such a place should be at least from $3,000 to $3,500 annually and the net income from $1,800 to $2,000.

If such an establishment is rightly planned in the beginning, it may be extended until the entire half acre is covered with glass. In such an event, of course, the grower will have to depend entirely on the outside for his soil and manure, but this is not a difficult problem in the vicinity of a city. The gross income from such an establishment should be from $10,000 to $12,000 and the net income from $3,500 to $4,000.

Specialization in this field will be conducted in about the same manner as already described, except that the grower will limit himself to one crop, such as roses, carnations, or violets. There are some advantages in this and some disadvantages. The advantages arise chiefly from the fact that it seldom happens that all three crops fail in one season, while it sometimes occurs that one crop, for reasons which can not well be controlled, either falls off materially or else fails completely. A complete failure, however, is or should be very infrequent unless through bad management or lack of knowledge on the part of the grower. Specialization offers opportunities for growing crops of the highest quality and for competing in the market for the very best prices. The cost of such work is practically about the same as for general flower growing, already described. The opportunities, however, are more restricted, for the reason that to compete in this field one must grow the very best material. In other words, to be a specialist means the growing of the very best of crops. To be a specialist, furthermore, means certain knowledge and a certain temperament which are difficult to find. The general gardener, or one who has been trained in the growing of a number of crops, very frequently fails when he attempts to specialize, because he knows too much about too many things to make a good specialist. Some of the best specialists in violet growing are men who have known little or nothing about growing any other crops, and have gone into the business from the workshop or from the farm. Going into business in this way, the prospective grower has no preconceived ideas or no-tions about how the crops ought to be handled; his whole mind is centered on one thing, and he is not carried away by suggestions coming to him as the result of former experience in producing other crops. What is stated here in regard to the owner is applicable, of course, to the men whom the owner must secure for his help. Given a bright, quick-witted young man, with no prejudiced views as to the growing of crops, he will in most cases make a better specialist than one who has had considerable training in general gardening work.—(Y. B. 1904.)

Plant Growing as a Specialty.—This is a field which is comparatively limited. The great improvement in transportation facilities has made it practicable to ship plants long distances; hence these plants are now turned out very cheaply and by the million in large establishments remote from the points where they are to be sold. Such being the case, the opportunities for the small specialist, or the farmer, are few and are growing fewer. If the field is entered at all, it should be considered mainly from the standpoint of getting into touch with some already existing large establishment with a view to obtaining experience and with the ultimate view of pushing the business to such a point that large shipping facilities may be developed.—(Y. B. 1904.)

Bulb Growing.—The very specialized conditions of soil and climate necessary for the proper production of bulbs and the peculiar nature of the skilled labor required have made the establishment of the bulb industry difficult. However, investigations have shown that nearly all of the so-called Dutch bulbs may be grown in the United States, and that one by one the difficulties due to competition of cheap skilled labor, excessive cost of transportation, and the natural hesitancy on the part of purchasers to use an untried article will be overcome. A method has also been discovered by the Department experts to produce the Bermuda lily bulb free from disease. Of the millions of lily bulbs annually imported, it is safe to say that 40 per cent are more or less affected by disease.

Whatever bulbs are used for this purpose, it will be to the interest of the grower to purchase none but the best. Most all the bulbs forced in this country are grown and imported from Holland; the Easter Lily,* Freesia and Calla Lily being exceptions, the two former being imported from Japan and Bermuda, the latter being native to California.

When the bulbs are received, which is usually during the month of October, they should be potted as soon as possible in a soil composed of good garden loam with one-third added to its bulk of well decomposed stable manure; the addition of a little sand is beneficial in order to keep the compost open.

In potting the bulbs the crown of the bulb should be on a level with the surface of the soil, making an allowance of one-fourth of an inch from the surface of the soil to the rim of the pot, to allow the plant to be watered thoroughly at all times when needed.

When the bulbs are potted, water thoroughly and place in a cool cellar away from heat, leaving them in this position until thoroughly rooted, which may take from eight to ten weeks; if the bulbs are well watered before being placed away in the cellar, they will not require to be watered again until they are brought up to the light in the dwelling house. They may then be watered and treated like other house plants. It is imperative for the success of either Tulips, Narcissuses or Hyacinths, that they be well rooted in the pots before being brought into the heat; if they are insufficiently rooted failure will result. To be in proper condition to force the pots should be matted around with roots. Many growers prefer to place the bulbs after being potted in the cold frame and cover them down with from twelve to fifteen inches of ashes or sand. They are kept in this position until wanted for forcing, when they are brought into the greenhouse in quantities according to the demand for them; a number being removed each week in order that a succession of blooms may be kept up in the greenhouse.

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* See illustration on page 519.

The following are among the best bulbs suitable for winter bloom: Hyacinths (Dutch), various colors; Hyacinths, Early White Roman; Narcissus, Princeps, Trumpet Major Horsfieldü, Von Sion, Paper White and Poeticus; Tulips, in great assortment, single varieties being the best suited for early forcing; Crocus, in assortment; Freesia, Refracta Alba and Purity.—(N. H. E. S. P.-B. 8.)

VOLATILE OIL AND PERFUMERY PLANTS.

Hosts of wild aromatic plants are found growing in all sections of the country, many possessing exceedingly fine fragrance and many, on the other hand, possessing odors less attractive but nevertheless possibly of value. These odorous plants will in most cases produce volatile oils which may contain constituents of value, not only in the perfumery trade but also in the arts and medicine. A systematic canvass of the flora of the United States, with special attention to those plants which possess an aroma, and a trial distillation of the same, followed by a careful, detailed chemical examination of the oils, will no doubt bring to light new oils, the value of which may be determined from the nature of the constituents identified in them. Several new volatile oils have been distilled which have been shown by chemical analysis to contain highly valuable constituents.

Various other plants deserving mention, besides those already cultivated and those growing wild which possess volatile products of value to the perfumer and confectioner, are the rose, lavender, rose geranium, rosemary, thyme, sweet basil, summer savory, and sweet marjoram, and the umbelliferous seeds (caraway, anise, fennel, and coriander). The plants of the first general class, though not native to this country, have been introduced and grown as garden plants, luxuriant growth and excellent aromas usually being obtained.

The umbelliferous plants mentioned have also been largely grown, although only on a garden scale, usually for their seeds, which possess considerable value to the housewife and to the confectioner for flavoring or condimental purposes. The distillation of the oils from these seeds has been very largely for experimental purposes only.

The rose, lavender, and rose geranium, although possessing exceedingly fragrant volatile oils, have received only trifling consideration as regards cultivation for the aroma.

It is not unlikely that certain sections of the United States are adapted to the growth of the Bulgarian rose, which produces the rose oil of commerce. In order to locate these desirable regions, practical tests would be required, attention being paid to the quality of the perfume obtained and also to the labor required in the gathering of the rose petals. Besides the usual variety of rose used for perfume cultivation, the *Rosa damascena*, there are a number of other species which have become naturalized in this country and which possess fragrance of exceedingly high quality, besides being prolific bearers.

Experiments in connection with the growing of roses for perfumery purposes are worthy of attention in some of the southern portions of the United States where the conditions of climate are especially favorable and where, since the petals must be plucked by hand for distillation, labor would be sufficiently cheap to insure a certain degree of success.

Lavender (*Lavandula vera*), now grown extensively in the semi-mountainous districts of France and in England for the volatile oil, is no less capable of growth on the soils of this country than other plants which are at present grown profitably. The regions of growth in France, Italy, and England are not entirely dissimilar and do not possess any more suitable climatic and soil conditions than might be supplied in some sections of the United States. In this case experiments would also be necessary to locate desirable regions, but the labor factor would be minimized considerably owing to the fact that the entire tops of the plants are distilled. Owing to the little labor required in connection with lavender, enterprise in this matter should not be lacking.

The rose geranium (*Pelargonium odoratissimum*), a plant with an exquisite odor, grown and distilled in France, Spain, Algiers, and the island of Reunion, deserves some consideration with regard to cultivation, inasmuch as the oil distilled from the plant is of such a nature as to make it almost indispensable in the perfumery industry. Unlike that of lavender, the odor of the rose geranium resides in the leaves, the flowers being almost odorless. Experiments in a preliminary way are now being carried on to determine the quality of the oil capable of being distilled from this plant. As in the case of the rose and lavender, the most suitable location can be learned only by a system of tests in localities with different climatic and soil conditions.

Rosemary (*Rosmarinus officinalis*), thyme (*Thymus vulgaris*), sweet basil (*Ocimum basilicum*), summer savory (*Satureja hortensis*), and sweet marjoram (*Origanum marjorana*), besides others of this type originating in Mediterranean countries and yielding oils of excellent fragrance for both the perfumers and the toilet-preparation manufacturers, can by proper attention and perseverance no doubt be produced advantageously. A factor of considerable import in the growth and distillation of these plants is that whole fresh herbs can be distilled, thus obviating the necessity of picking the flowers by hand.

The distillation of oil from such seeds as caraway, anise, fennel, and coriander, which are so universally used for flavoring and scenting purposes, has been successfully exploited in southern Europe for decades. These seeds have been introduced into the United States and grown in small quantities, principally for household use. The ease of production as a household necessity should be sufficient stimulus for growing the plants on a broader basis for the distillation of the very fragrant oils. The North-Central States, with their excellent soil and climate, undoubtedly are capable of producing profitable yields of seeds giving from 2 to 7 per cent of volatile oil. The method of distillation is similar to that of leaves or herbs, with the exception that, in order to facilitate the permeation of the steam, the seeds are ground coarsely before being subjeced to the steam vapors.

In the manufacture of perfumes the role played by volatile oils is all important. A large proportion of the amounts consumed enters the channels of the perfumery trade. Usually perfumes consist of blends of odors brought about by a skillful combining of several oils in varying proportions through a medium capable of holding in solution these oils and odoriferous ingredients. The manufacture of perfumes has shown but little development in the New World. Perfumery products are largely imported in the prepared condition, chiefly from France, where the skillful art of compounding has been scientifically developed.

The use of volatile oils in flavoring and in the manufacture of flavoring extracts is very extensive, but it is restricted to a comparatively small number of oils, principal among which are lemon, orange, wintergreen, peppermint, and others of this type. For scenting purposes, such as aromatizing soaps and toilet preparations in general volatile oils have been employed very extensively in the United States. Their use in this line of application has increased with the increase in the manufacture of these much-demanded articles.

On the other hand, the medicinal value of certain oils and of certain constituents which can be isolated from them has created a demand which in part has been supplied by home production and in part by foreign production. The separation of important therapeutic ingredients, chiefly antiseptics, has been highly serviceable in the treatment of many ailments, a striking instance of this kind being the separation of camphor from the oil of camphor, this ingredient playing an important role in medicine as well as in the arts. Other oils deserving mention in this connection are those of eucalyptus and thyme, the former yielding the valuable eucalyptol and the latter thymol. Another example is peppermint oil, from which menthol is isolated. All of these constituents possess therapeutic value of no little importance.

The Mediterranean regions of Europe are the chief sources of these aromatics, which are so generally employed in the industries in diverse ways. The cost of production is minimized in these countries because of the cheaper class of labor, as compared with labor in America, for instance. In the handling of many flowers and plants, much hand labor is required, especially in the collection of the material prior to distillation. The actual distillation and purification of the oils can be conducted with equal economy in the United States, while in the case of no small number of plants which may be suitably collected and distilled in the whole condition the question of labor becomes a less serious factor, especially in some instances where mowing machines may be employed advantageously to harvest the crops. Where hand picking is required, as in the case of some of the more delicate odors from flowers and flowering tops, cultivation and extraction of the odor could possibly be carried out in the Southern States, which have abundant sunshine, an important prerequisite in odor development. Furthermore, the labor conditions in the Southern States are such that the cost of gathering, which is a serious obstacle, would be comparable to a degree with that in foreign countries.

From the standpoint of the consumption of products derived from volatile oils obtained from plants, the commercial statistics show a large and active market. They also show that the demand is now supplied in very large part from foreign sources. The future financial possibilities along this line for the scientific, up-to-date farmer seem very great.—(B. P. I. B. 195.)

The Growing of Flower Seeds.—Various flowers have been grown for seed, in fact, a great assortment of varieties; and while nearly all kinds flourish, there is so much handwork and close application necessary that we have not been able to successfully compete with Europe on most things. Sweet peas, nasturtiums, cosmos, verbenas, petunias, and asters are quite successfully grown, and the seed trade now looks to California for most of the sweet peas and a great many nasturtiums.

Southern California has several very prominent growers of fine double petunias and other plants. The rapid advance of the California sweet-pea seed in popularity is most marvelous. A beginning was made in this line in a moderate way about 1885, when there were not over a dozen varieties listed. At first about a quarter of an acre was grown; now one grower alone has grown from 150 to 200 acres of them each year for the past five years, and there are no less than 125 varieties in his complete list. This grower has introduced more than 20 varieties of great merit in the last three years, among them the famous race of "Cupids." So important a factor have the California sweet-pea growers become to the seed trade that some dealers come from the East annually to inspect the growing crops and to hunt for novelties in the sweet-pea line.

Some flower-seed growers devote themselves largely to the production of new varieties. The seeds of these bring a better profit than those of the common sorts, which can be more cheaply grown in Europe.

In the Eastern United States flower seeds have been grown to some extent for at least fifty years. In 1849 James Vick began to grow flower seeds in New York State, and during the sixties flower seeds were grown in New Jersey, Pennsylvania, New York, and in New England. The amount raised was, however, never more than a small portion of that needed for the trade, and the greater part of the flower seeds sold was imported from Europe. This condition exists to-day. Flower seeds are grown in a number of places throughout the United States, but only a small portion of the trade is supplied with home-grown seed. Outside of California, limited amounts of flower seeds are grown, the principal kinds being asters, phlox, petunia, verbena, portulaca, zinnia, balsam, hollyhock, pansies, sweet peas, begonias, coleus, and some greenhouse plants.—(Y. B. 1899.)

MAGNITUDE OF FLOWER GROWING AS AN INDUSTRY.

If the farmer will study the following figures which were compiled some years ago he will readily see the financial possibilities in commercial flower farming by greenhouse methods. These figures do not include the flowers grown as field crops.

There are not less than 9,000 commercial florists' establishments in the United States. Some of these contain areas of glass which cover acres, while others contain only a few hundred square feet. Taking the country as a whole, it is estimated that there is an average of 2,500 square feet of glass for each establishment, or 22,500,000 square feet in all; New York has the largest number of establishments, there being not less than 1,100 or 1,200, with glass amounting to nearly 4,500,000 square feet; Illinois, with 600 to 800 establishments and over 4,250,000 square feet of glass, is second; while Pennsylvania, with 800 or 900 establishments and about 4,000,000 square feet of glass, is third. The estimated value of the establishments in this country, including houses, boilers, and all fixtures, is placed at 50 cents for each square foot of glass, or $11,250,000 in all. The income to the producer will average 50 cents per square foot annually, or $11,250,000, and double that amount when viewed from the standpoint of the retailer. Considering the matter from the retailer's standpoint, therefore, the total value of the annual output is $22,500,000, or $1 for each square foot of glass.

It is estimated that the retail value of cut flowers sold annually is $12,500,000, the estimated apportionment of this sum being, for—

Roses	$6,000,000
Carnations	4,000,000
Violets	750,000
Chrysanthemums	500,000
Miscellaneous flowers, including lilies, etc.	1,250,000

Estimating the average retail value of roses, carnations, and violets at $6, $4, and $1 per hundred, respectively, the total number of each sold annually, based on the above values, would be, of—

Roses	100,000,000
Carnations	100,000,000
Violets	75,000,000
Total	275,000,000

The retail value of the plants sold is placed at $10,000,000. Taking the plant trade as a whole and the country in the aggregate, the average-sized pot used is estimated to be 3 inches, and the average retail price 10 cents per pot. This means that there are no less than 100,000,000 plants sold every year.

To handle this business in its entirety requires probably an average of not less than one man for every 1,500 square feet of glass, or 15,000 men in all. Fifteen hundred square feet of glass per man may seem like a low estimate, and such is the fact when considering commercial establishments of any size. The larger the area of glass, other things being equal, the more square feet one man can handle. As a matter of fact, some of the large rose-growing establishments do not use more than one man for each 10,000 square feet. Large carnation establishments will run about the same as roses, while violets, owing to the great amount of work involved in cleaning the plants and picking the flowers, average higher. It is the many thousand small establishments that increase the amount of labor required.

Methods for Disposing of the Flower Crop.—In conclusion, the farmer's attention is called to some of the modern methods of handling and disposing of the vast amount of plant material produced.

Many of the crops grown pass through several hands before reaching the consumer. Some of the larger establishments, especially those devoted to vegetable growing, dispose of their products through special agents, who receive a salary for this work, and are expected to keep in close touch with the markets and look after every detail, so as to obtain the highest price for the material handled. That such a method pays and pays well is evident from the fact that some of these agents receive salaries exceeding any paid by ordinary business establishments except in very special lines.

Auction sales are another important innovation which enables the plant grower to dispose of much of his stock. Within the past few years these sales have become quite popular, and have done much toward broadening the opportunities for work, especially in plant growing.

A vast amount of stock, especially cut flowers, is now handled by wholesale commission houses, which are to be found in nearly all the large cities. These houses have every facility for the rapid handling of flowers, and afford to the growers an opportunity of disposing of stock which a few years ago was not possible. Some of these wholesale men are already finding it necessary to specialize, and for this reason are making reputations for having on hand the best in the market in the way of roses, violets, or whatever their specialty may be.

In addition to wholesale commission houses, there are in some larger cities cut-flower exchanges, which handle a great deal of stock. These exchanges are controlled and managed largely by growers themselves, and are conducted as nearly as possible on an equitable basis. The New York Cut Flower Exchange has been in existence for five or six years, and its success has been quite marked. It has for its supporters some of the best growers in the Eastern United States, and the prices received through this co-operative plan are said to be very satisfactory.

In close touch with the commission houses and exchanges are the retail stores, which are by far the most important factors in connection with this business in the matter of handling and disposing of stock. The amount of flowers and plants handled by these establishments in some of the large cities is almost incredible. Undoubtedly the annual sales of some of the best establishments of this kind in New York City will not fall short of three or four hundred thousand dollars. The stores themselves are looked after with the greatest care, every attention being given to the satisfying of artistic desires on the part of the customers. As already pointed out, the successful men in this business are those having sufficient artistic ability not only to cater to the demands of the customers, but to create new fads. The arrangement and handling of the flowers, the boxes, ribbons, delivery wagons, messenger boys, and every detail must be of the most artistic kind in order to attract attention and draw trade.

It frequently happens that, owing to circumstances, quantities of flowers are left on the hands of wholesalers, commission men, and others. Most of this material is now disposed of to a class of men known as street fakers, who often play an important part in relieving the pressure on an already full market. These fakers are to be found everywhere in large cities, and, with their push carts and other facilities for locomotion, they are doubtless able to supply a class of trade that could not be reached in any other way.

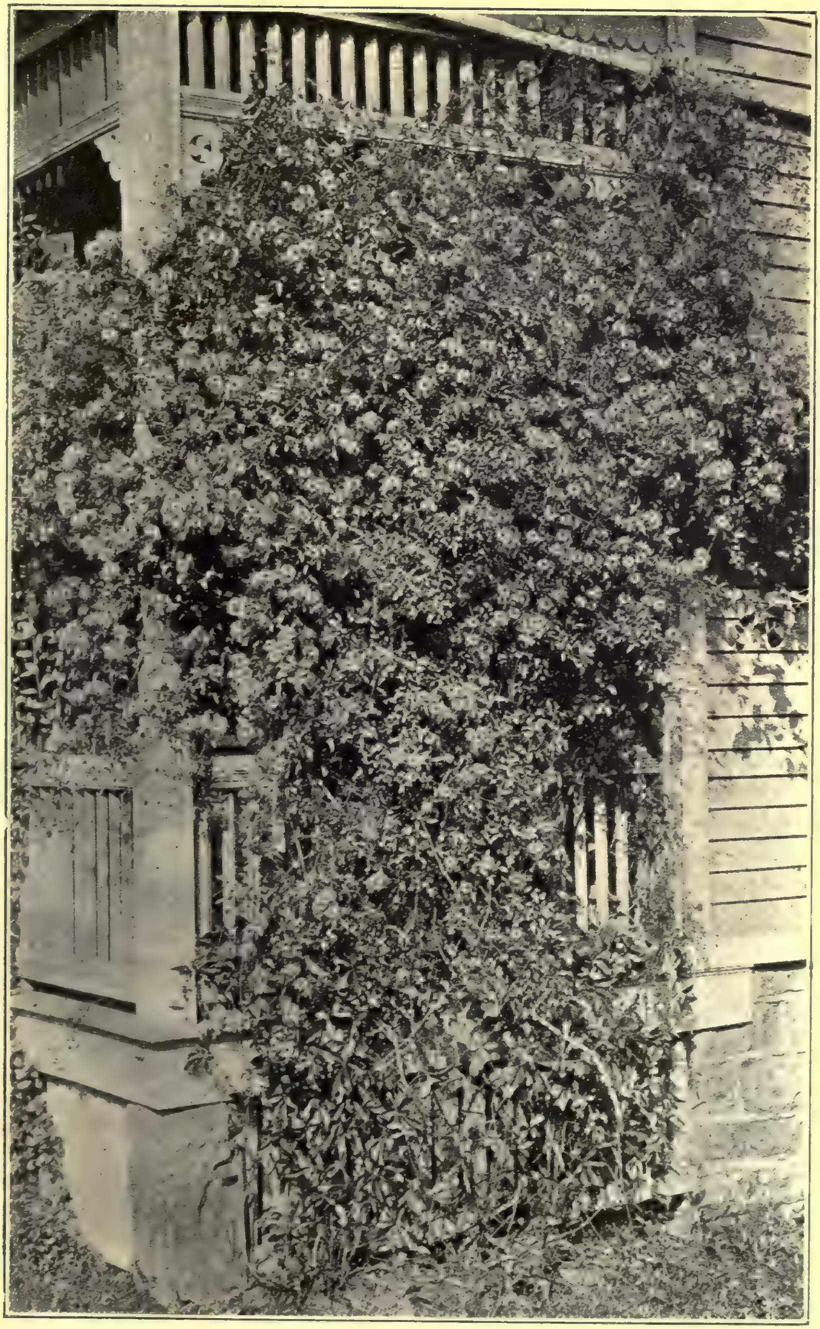
Through the trade journals growers, wholesalers, and retailers are kept in close touch with each other. These journals are published weekly, and each has its staff of special correspondents, who watch the markets and call attention to every detail worth noting.—(Y. B. 1899.)

CONSTRUCTION AND MANAGEMENT OF HOTBEDS.

The hotbed is an essential adjunct in good gardening, and yet it is surprising how little the management of hotbeds is understood. Certain plants and many flowers require longer time than the average length of seasons in the north to reach maturity, and have to be started and partly developed under artificial conditions. Others that do mature within the length of the warm seasons, can be brought to maturity earlier, and the time of use prolonged by employing the hotbed to secure early development.

The conditions to be secured in hotbeds are protection from external influences, heat, moisture, and air, all of which must be secured and harmonized to a proper degree to suit the requirements of plant growth and development. Most seeds can be germinated with very little difficulty if they have been properly saved and their vitality preserved in storage. The management of tender plants, however, raised under artificial conditions, is a matter requiring good judgment and some skill.

Frame.—Sufficient protection must be afforded to keep out cold and prevent influences of weather changes. For this purpose a frame built of inch lumber will answer the requirements. A hotbed of or-



Vines of American Clematis (Virgin's Bower) as Piazza Screen, in Fruit.

dinary size should contain at least 45 square feet of ground surface, say five feet wide by nine feet long. The sash or top covering should slope toward the south to admit the sun's rays and to allow the water from snows and rains to drain away readily. The frame should be made of a size to accommodate the sash or the sash can be made to any size desired and adapted to a frame of certain dimensions. At any rate the edges of the sash should just overlap the frame all around to secure closed joints. The slope of the sash should be made to drop about two inches in every foot. Sometimes posts are driven in the ground at the four corners and boards nailed to them, but this is not the best means of construction. Posts are not needed. Corner blocks are better, and they should not project below nor above the edges of the boards, but flush with the edges. Pieces of 2 by 4 scantling make good corner blocks. The front board of the frame should be 12 inches wide, the height of the frame in front when finished, and if the frame is to be five feet wide the back should be 22 inches high and the ends sloped to meet the top edges of both front and back. Braces will be needed clear across the frame on the inside. Two or three will answer, but they must be provided and properly distributed to prevent crowding the frame out of alignment when the banking of earth is thrown up on the outside, a protection necessary to early planted beds.

Sash.—These can be purchased ready made, or any person handy with tools can make them and in this way often save expense and usually secure better construction. The ordinary ready made hotbed sash has been found to be a flimsy article. The usual length of ready made sash is six feet, which necessitates the construction of beds about six feet wide. This width is very inconvenient for planting, weeding, thinning, watering, and finally in taking up the plants for transplanting. Access to the bed is almost always difficult excepting at the front or lower side, and a reach of over five feet is too great for convenience. A good sash can be made as follows: For convenience in figuring, assume the size of glass used to be 10 by 12 inches, although other sizes are admissible. There will be three rows lengthwise of the slope, and each row will contain five lights. The long way of the glass shall be in the direction of the slope when in use. Two end pieces of wood, two side pieces, and two sash bars intermediate, running lengthwise, will be required. The intermediate bars must support the center row of glass and the two inner edges of the two outer rows of glass. To do this the corner edges of the upper side of the sash bars must be rabbeted or cut out a quarter of an inch wide and a quarter of an inch deep. The inside edges of the side bars must be accordingly rabbeted to receive the glass and form their support. The side bars like the others should be an inch and a half in thickness, but about two and one-half inches wide. Thus there are grooves for three rows of glass. The end pieces should be of inch and a quarter material and have the ends of the sash bars joined to them by means of mortise or groove connections. In setting the glass a quarter inch lap should be made over each other, as in laying shingles, but a lap of at least a half an inch should be made over each end connection with the wood. Before setting the glass it is best to apply two coats of lead paint to the sash. If zinc points are used instead of nails in setting the glass, breakage will be best avoided. Putty can be used or not, but by its use greater strength and durability are secured.

The Pit.—The depth to make the pit for the heating material, the manure, will depend upon how long a period it is desirable to have the heat maintained. Hotbeds constructed late in February or early in March will need to have heat kept up for several weeks, or until the warmth of the spring season has tempered the surrounding soil. In this case a depth of four feet will maintain proper conditions. Ordinarily about April 1st is the best time to start hotbeds to raise plants for the garden. At this time two feet in depth of manure will secure all the heat necessary. Good drainage must be secured at the bottom surrounding the pit. If water from snows, rains or springs is allowed to enter the manure the heat will soon be destroyed.

To utilize the entire hotbed surface, it is not enough to have heat only from below. If the pit opening is made no larger than the size of the frame, the sides and ends will always be too cold to develop plant growth around the borders. For this reason it is best to make the pit one foot longer each way than the frame, which will extend the heating surface beyond the borders.

Heating Material.—This should be from the horse stable and as nearly free from coarse litter as careful forking over will separate it. Horse manure thrown in a compact heap will start fermentation in the coldest weather. Therefore it is best to save manure for the hotbed by keeping it spread in thin layers in a dry place or open shed until about the time wanted for use. By partial fermentation of the manure before use some of the heat becomes lost, and its utility is impaired. Very dry manure should be moistened at the time it is prepared to put into the pit. It is very desirable to have the heat well established and to see that the whole mass begins fermentation at the same time. This can be accomplished by thorough forking over and repiling once or twice.

The use of manure from cattle should be avoided as it furnishes no heat and tends to cool the horse manure if mixed with that material. Until the pit has been filled the frame is left to one side. It is important to have the material so filled in that it will settle with an even and level surface. Thorough forking over and tramping all parts alike will accomplish just what is desired. After the pit has been made a little over full the frame can be placed in a level and permanent position, and about four inches more of manure filled in. Let the strong ammonia gas escape for three or four days and then add six or eight inches of rich garden soil with which has been mixed about one-third of its bulk of thoroughly decomposed barnyard manure, well pulverized. The sides and ends should be well banked with the soil previously taken from the pit, and in doing this the main idea is to secure good surface drainage. The sash should be put on as soon as the seed bed has been prepared, and planting can be done any time thereafter. A few inches of settling always takes place as the manure becomes compacted, but if the whole mass has been evenly built up no irregularity of surface will result as would in the case of a frame built stationary and filled in the old style manner of constructing hotbeds.

Planting.—The soil of the seed bed should be quite moist but not wet, to be in the best condition for planting. Six inches between rows is about right for distance. Closer than this will cause slender growth in most plants, and a greater distance than six inches would ordinarily prove a waste of space. In marking the rows for planting the old method of scratching the soil with a stick drawn along the edge of a board is usually unsatisfactory as it is impossible in this manner to get the seeds covered to a uniform depth. The marks should be made by pressure instead. A good marker for a hotbed is made by taking a board six inches wide and of a length the rows are to be made. Along one edge of the board a strip is nailed projecting below the edge about a quarter of an inch as the board lies flat upon the soil, and should form a V-shape projection, which is imprinted in the soil by walking on the board. Each time a row is planted a mark is made for the next, and so on until the planting has been finished. The seed is covered by sifting the grooves full of fine soil, after which a thorough sprinkling with water settles the particles of soil about the seed and insures uniform conditions. For some seeds of a light nature, a quarter inch groove in the soil would be too deep, in which case a gauge of proper depth can be easily provided.

Moisture.—While seeds are germinating, the soil should never be allowed to become dry even for a brief period. If the growing germ or even the seed leaves ever become dried out, recovery can hardly be expected of most plants. It is, therefore, of the utmost importance to afford protection to seeds and young tender plants during the first stages of growth, especially in respect to furnishing a constant supply of moisture. Evaporation of moisture is usually very rapid at the surface of the soil when unprotected by some kind of mulch. A thin layer of moss is sometimes used to arrest evaporation until the plants become well rooted. A very practical substitute for moss has been found in the use of a single thickness of cheap muslin spread, in contact with the soil, over the seed bed immediately after planting. Watering can be done without removing the cloth, which can be left on until the plants by their own force of growth lift it in well defined ridges, and become safely established by their roots penetrating well into the soil. There is not as much danger of drying out after plants become deeply rooted. The appearance of the foliage will always indicate the supply of moisture present. It is a fact, however, that very many persons fail in their judgment in regard to irrigating hotbeds. Water should be furnished most liberally when it is applied. The soil should always be saturated to a depth below the limits of root growth, and then the water withheld until the foliage clearly indicates the need of more moisture. Frequent light surface waterings hinder root development and plants so managed are sure to become dwarfed and show lack of vitality.

Heat.—Bottom heat favors root development. Excessive top heat, that is, confined atmospheric heat, with too low temperature at the roots favors excessive top growth. Plants raised under the last named conditions have not their vital forces well enough balanced to transplant well and sustain themselves through the changes, without suffering deterioration from which they never fully recover. Too much top heat from the sun's rays is often the cause of plants becoming languid before transplanting from the hotbed. During warm sunny days the glass should be removed or tilted back, and during very warm days when the atmosphere is at a high temperature, shade should be provided. Lath screens made the size and to take the place of each sash, render very good shade protection. The spaces should alternate with each lath and be of the same width. During warm nights, say at a minimum temperature of 45 degrees, it is best to leave off the sash, as such exposure tends to make the plants hardier.

Air.—Plenty of fresh air is needed by plants at all times, and especially while a high temperature prevails, and plants are in the activity of growing. Good judgment may determine when and how much to ventilate, and a thermometer hanging in the frame will afford something of a guide. About seventy to seventy-five degrees is a good day temperature and 45 to 55 degrees for night.

Transplanting.—A common error is in allowing plants to remain too long in the hotbed before transplanting. They are usually allowed to grow without thinning, as it seems to most persons a sacrifice to destroy the things that have cost labor and painstaking care. Left in this way slender growth will always be the result, and much time is sacrificed in nursing the plants back to the vigor they once possessed before they became too cramped in growth. Again, do not plant hotbeds too early, as young thrifty plants set in the open ground have a decided advantage over those left too long in the seed bed and weakened by spindling growth. If plants are inclined to grow tall and crowd each other before the season will justify transplanting to the open garden, it will prove wise economy to thin them enough to insure good healthy and stocky vigor. If it is desirable to save the plants removed by thinning they can be transplanted to other beds with perfect success. A hotbed is not necessary to receive them, but what gardeners call a cold frame can be provibed. This is in every sense a hotbed prepared without the heating material, but otherwise constructed the same. Some plants are somewhat difficult to transplant excepting while very young. It will pay to provide small pots, or something of the kind, while the plants are very small and can be taken up with soil adhering. Started in this way they can at any time be shifted to larger receptacles and given more room as increased growth demands, and the soil need not be disturbed from the roots. A good substitute for pots is old one-quart tin fruit or tomato cans. They can be unsoldered, the bottoms removed, and the circular shape preserved by wrapping and tying with stout string. When shifting these bottomless cans a trowel can be run under them and they are lifted without the contents falling out at the bottom. The strings can be removed in transplanting and the ball of earth preserved intact. Another device is: Instead of planting seeds in the seed bed as previously described, long, narrow, trough-like boxes or trays can be sunk in the earth side by side and each be made to contain one row. Correct spacing of rows can be had by their use. To have these serve the intended purpose plants must be thinned to spaces of about two and one-half to three inches in the row. When the time comes for transplanting, the troughs can be carried to the place of planting and the use of a sharp garden trowel will enable one to take up each plant without breaking the soil about the roots, and shift to the open ground with almost the advantage secured by the use of pots. Troughs are recommended three and one-half inches deep, three inches wide inside at the top, and a little less at the bottom to make them flare. The bottoms should be covered with stiff galvanized wire netting of quarter inch mesh. The use of three-quarter inch lumber serves the purpose well for sides and ends. Three of these trays to display bottom, top, side and ends and their manner of construction may be used.

A good serviceable covering for late-prepared hotbeds is heavy muslin to take the place of sash. To render the cloth impervious to water, and durable, it should be coated with boiled linseed oil, applied with a paint brush. Narrow strips of boards to which are tacked the long margins of the cloth, serve to stretch the cloth over the frames and render handling a convenient operation. During cold days and nights beds with cloth coverings need the additional protection of board shutters made solid and in sections to lay over the cloth. Such shutters are very practicable also for use over glazed sash where beds are planted very early and severe cold weather follows.

A good substitute for early hotbeds is the use of shallow boxes, called "flats," in which seeds are planted, and afterwards the young plants may be shifted to late prepared hotbeds. Flats can be handled with good success in an ordinary room with a night temperature maintained at not below fifty degrees. They should be prepared with good soil and always be kept reasonably moist. Good means of drainage at the bottom is important unless great care is observed in watering. Before the soil is put in, a cloth is laid over the bottom to prevent leakage. The open bottom as shown insures perfect drainage and admits the air to keep the soil pure and free from fungus diseases. Provision is made for glass over the top to save the rapid evaporation of moisture over the germinating seeds, which will occur in a dry room if the top is left open. About two inches of soil is sufficient for the germinating process, although a little deeper soil will hold moisture to better advantage.

Plants should never be allowed to suffer a check in their development from the time they appear until they become well established in the garden. The time of maturity may be hindered several weeks by a single period of neglect. Keep plants growing thriftily at all times is the best safeguard to success.—(Idaho E. S. B. 17.)

COLD FRAMES.

Cold frames are devices intended to protect plants from cold without forcing them into growth. They differ from hotbeds in that no artificial means of heating are employed. The cold frame in its simplest form consists of a frame constructed like the hotbed frame. The back board is usually 12 inches and the front 8 inches wide, and the two are connected by a tapered board 12 inches wide at one end, 8 inches wide at the other, and 6 feet in length. The back and front of the frame are made in multiples of 3 feet in length, with an inch added for each division space between sash, which is provided for by the use of a T-shaped piece let into the frame to stiffen it and serve as a guide for the sash. When complete, the frame is placd upon a sheltered, well-drained piece of ground convenient to some main line of traffic between the house and some other important and frequently visited portion of the grounds. The frame, as above stated, is made to carry hotbed sash. The glass allows the sun during bright days to temper the air of the frames, so that by properly covering them at night with shutters, straw, or jute mats the heat can be retained and the plants within safely carried through severe weather. The frames may be banked with earth as an added precaution against cold.

The chief precaution which must be observed in the management of a cold frame is that of proper ventilation. The object of this device is to retain plants in a healthy condition without adding to their growth. It is therefore very essential that the temperature of the frame at all times be kept at a degree which will not induce rapid growth. High temperatures and abundant humidity induce growth. The management of the frame should be so directed that during bright, sunny weather the sash may be lifted sufficiently to admit outside air in order to preserve a low temperature about the leaves of the plants. In some cases it will be found that during bright days even in midwinter the sash will have to be removed from the frame for a few hours at midday in order to preserve a sufficiently low temperature. On the other hand, care should be exercised in ventilation and watering so as not to reduce the temperature of the frame late in the afternoon, as such treatment is liable to lead to frost injury.

It stands to reason that only the hardiest plants can safely be carried over winter in a cold frame. Many of the plants which are grown as annuals will, with protection, become perennials or can be made to give a much longer period of bloom if sown in the autumn and carried over winter in a cold frame. Among plants which will be greatly benefited by such treatment are pansies, dianthus, and chrysanthemums.

Pits.—The pit is a more elaborate and efficient cold frame which, as its name indicates, consists of an excavation. This excavation may be from 2 to 4 feet in depth, with sides protected by plank or brick walls, upon which a frame similar to the one described for the cold frame is placed and covered with sash. The pit has an advantage over the cold frame for some purposes. It can be used, for instance, to store some of the hardier flowering plants which are to be placed in tubs or vases about the lawn during summer. Plants in a pit are protected by the warmth of the soil. In latitudes where the pit will be found of greatest use the soil does not freeze to a depth of more than 10 to 15 inches. Seedling plants may be held over winter in trays or flats in pits as safely as in frames.

The same precautions in regard to ventilation, covering, and watering must be observed in the care of a pit as in the case of a cold frame.—(F. B. 195.)

A COUNTRY GREENHOUSE.

The successful farmer aims to secure the greatest results with the least expenditure. The following country greenhouse for general use, on account of its minimum cost, the wide range of its utility and the results it will produce, will appeal to all.

A large part of it can be made from lumber of the cheapest grade. Choose a sunny location that will be convenient to the house. Begin by making an excavation three to four feet deep by ten feet wide by any multiple of eight feet in length, depending upon the capacity desired. The long way of the house should be north and south. If the ground is very wet the excavation should be drained. Inside of this excavation set posts, preferably cedar, six feet apart with the tops extending just above the ground. Saw off the posts at an angle to correspond to the desired pitch of the roof and on them spike a two by four for a rafter plate. The rafters should be also two by fours and spaced for the ordinary three by six hotbed sash. The rafters should be notched to the plate for greater rigidness. The sash should be screwed on them and the joint covered with a weather strip. The ridge joint should also be protected with comb boards. In the first place the posts should be set at a distance of several inches from the walls of the excavation. On the side next the excavation wall they should be boarded with heavy boards, and the dirt then tamped in the intervening space. On the inside of the posts nail boards with a close joint such as shiplap. Between the two walls is left an air-chamber which can be filled in with sawdust or fine manure. In the south end of the house make a window at least two feet square and in the north end make the door. An inclined walk to the door should be made. It is much more convenient than a stairway. These openings give good ventilation for general purposes. Both ends of the building should be heavily boarded on both sides of the joists and the intervening air space filled with sawdust. Through the center of the building in line with the openings should be left an alley. Hotbeds may be constructed and filled with the heating material as detailed in the description of hotbeds. Or, if fire is to be used in the building, the regular greenhouse bins and boxes may be used on either side along the alley. Circumstances will determine which shall be used. If flowers and vegetables are to be kept in storage for home use or higher prices, the greenhouse bins and trays, which can easily be removed, may be the better. The added cost of fuel will be a consideration which should not be overlooked. The average farmer can, if he so desires, make his basement walls of sand and gravel and cement. In a combination greenhouse and hotbed as just described, there are many advantages over the ordinary hotbed. First, there is no danger of breakage by the wind and a consequent injury to the tender plants; second, it can be cared for more easily and safely; third, more air space is afforded above the plants with consequently less danger of sun-scald, and ventilation is afforded; fourth, it can be heated; and fifth, it can be used for storage purposes.—(S. Dak. E. S. B. 47.)

THE COMMERCIAL GREENHOUSE.

The truck farmer who is raising flowers and vegetables for the city market, and the beginner in flower culture may want to start with a commercial greenhouse—one which is not too expensive. A nine by twelve metal frame house complete can be purchased for from $80 to $115. A nine by twenty feet will cost about $250. The lean-to type which is made to join the residence so that it can be heated from the dwelling furnace is an economical and favorite type with the farmer and truck gardener.

After choosing a location which from the greatest number of standpoints is desirable, make the excavation as detailed for the country greenhouse so the end of the building is to the south. The foundation to the surface should be of grout (sand, gravel and cement). The remainder of the wall should be preferably of two to four thicknesses of boards, two of building paper and then an air space. It is economy to buy only the best materials. All joints should be rigid and waterproof. Be sure that the glass is double strength and contains no burning pieces; it will mean economy in fuel and save many of the plants from sun-scald.

Hot water is considered the best heat, piped for both overhead and underbench, with pipes one and one-half to two inches in diameter which run between five and ten cents per foot. If it is not convenient to heat with hot water, an inside oil heater can be used. For the Northwest, where wide and sudden drops of temperature are frequent, this is the advisable heat to use. The smoke flue should be so constructed however that no gas escapes into the plant house. An inside coal fire should never be used in the raising of flowers. Practically all of the manufactured greenhouses can be fitted with mechanical devices for ventilation at both eaves and comb.

Accessories for the greenhouse are prepared earth and fertilizer in bins, shallow propagation boxes, boxes four inches in depth for large plants, one, two, three and four inch pots, a vessel for watering the plants, a vessel in which to wash the pots, a drainage box, fumigating materials, Bordeaux mixture, a spray, a trowel and a fork. As far as possible the commercial greenhouse should be adapted to the special crop to be produced and constructed with economy in space, heating and cost.—(Mich. E. S. B. 63.)

GREENHOUSE SOIL.

One of the most vital and important questions to the success of growing plants under glass is the soil, for upon a proper understanding of this depends in large measure success or failure in the work. While science has done a great deal to advance our knowledge of the relation of soils to the growth of plants, there yet remains much to be accomplished in the practical interpretation and application of the knowledge gained. The men to-day most familiar in a practical way with the requirements of different plants, so far as soils are concerned, are those actually engaged in agricultural and horticultural pursuits. By the appearance of the soil to the eye and by the way it feels when taken in the hand, a gardener can tell pretty accurately whether a certain soil will be suitable for a certain kind of crop. This knowledge is largely intuitive, and has been gained by long experience and close observation.

Speaking generally, it may be said that the perfect development of any plant, so far as the soil is concerned, depends upon two fundamental considerations: (1) The presence of the necessary amount of suitable food, and (2) the physical properties of the soil—that is, its texture and its relation to heat, air, and water.

That growth is dependent on the presence of proper food in the soil is now well understood, but how to supply this food so as to obtain the largest yields at the least expense is a problem of the utmost importance to everyone growing plants under glass for commercial purposes. As the work is now carried on, there are but few crops where it is practicable or desirable to add sufficient food at the start to carry the plant through the full season of growth. Feeding must be done through the entire growing period, and to do this properly is one of the most important problems with which the commercial grower has to deal.

The relation of the physical properties of the soil—texture, temperature, and moisture—to plant growth is not so well understood nor appreciated. It is obvious that these are not intimately connected with the chemical properties (food supply); in fact, it is a matter of common observation that the mere presence of an abundant supply of food is not sufficient to make a good crop, even though other conditions outside of the soil are to all intents and purposes perfect. This is well illustrated in the growing of roses, carnations, and other flowers. Certain varieties of roses and carnations may be grown to a high state of perfection in some sections, using, of course, proper judgment and skill in the management of the conditions. In other sections, and they need not be remote, it is difficult to get a perfect crop, although the skill of the grower may be fully as great as in the former case, and the use of manure as food may have been fully as judiciously made. In such cases the texture and structure of the soil, which involve also the capacity of the latter for heat, moisture, air, etc., may be the basis of the trouble, and all these have a direct influence on food supply.

By texture is meant the character of the particles which make up a soil, while structure has to do with the arrangement of these particles and their relation to each other. The particles, or grains, of which soils are composed vary greatly in size, and to distinguish them they have received certain conventional names, such as clay, fine silt, silt, fine sand, sand, etc. The clay particles are extremely minute, silt grains are larger, and so on until we have coarse sand or gravel, with grains 2 mm. in diameter.

Upon the amounts of the various constituents present, i. e., clay, fine silt, silt, fine sand, etc., will depend the porosity of the soil, the readiness with which air penetrates it and water moves through it, its water-holding capacity, and, finally, its temperature.

It will be seen, therefore, that the texture and structure of a soil have an important bearing on the development of the plant, affecting not only the growth of the roots, leaves, stems, and flowers, but the relative proportion of these and their relation to each other.

By varying the texture of a soil, its water content is varied, its capacity for heat is modified, and so on, until every important factor, including food, in the ordinary acceptance of the word, is involved. To these variations the plant adapts itself, and the result may be excessive leaf development, with few or no flowers, or vice versa; a weakened condition of the tissues, making the plant subject to the attacks of parasitic enemies, especially fungi, and so on through a list of other possibilities. To illustrate, we may have a rose grown in a soil of a certain texture and structure. The water capacity of this soil is most favorable for growth, and may be represented by 10. The capacity for heat, permeability to air, and the readiness with which water moves through it are also ideal, and may each be represented by 10. These conditions may so act on the food in the soil as to place it at the disposal of the plant in the most suitable form, so that food supply may also be represented by 10. Suppose, now, the texture of the soil is modified by the addition of clay; the water content of the soil is changed, this in turn affects the access of air and also the temperature, and the food supply is involved by the effects of the different changes on certain soil organisms, which play an important part in the matter of food. As a result of these various combinations and changes, we may have the water capacity of the soil represented by 12; capacity for heat, permeability to air, readiness with which water moves, 8; food supply, 8, etc. It will thus be seen that the plant in this case has an entirely different set of factors to which it must adapt itself, and in doing this it may so modify its development as to become unprofitable; that is, the new set of factors may give a good leaf development at the expense of flowers, or if a certain leaf development is wanted, as in the case of plants like lettuce, the color and texture may be changed to such an extent as to make the crop unprofitable.

It will, of course, be recognized that in the growth of plants under glass the conditions surrounding them are under far better control than those outside. Hence the gardener who grows plants in greenhouses has a wider range in the use of soils than he who grows them outside, for if the texture is not exactly suited to the requirements of his plants, he may partly overcome the difficulty by the judicious use of water and rigid attention to other conditions. There is a limit, however, beyond which even he can not go, and the nearer he approaches this limit the more care he must exercise in his work, otherwise the plants will suffer. The nearer the ideal soil conditions for each crop are attained, the less, other things being equal, will be the difficulties in the way of successful crop production.

Owing to the fact that we have no definite rules to follow in this matter, it would be well for everyone growing plants on a large scale to have constantly under way experiments to obtain light on the subject. Such experiments may be made on a small scale, will cost but little, and would doubtless be the means of bringing many interesting facts to light. Some soils that do not give the best results for certain crops might be greatly improved by the addition of clay, sand, or silt; in fact, there are any number of combinations in this direction that might be used to advantage.

Water, Heat, and Light.—The importance of water in the growth of plants under glass has already been briefly referred to in discussing the question of soils. It is hardly necessary to say that the proper use of this element is the keynote to success; in fact, it has been truly said that he who does not know how to water plants does not know how to grow them. No absolute rules can be laid down for the use of this all-important material, as knowledge on such matters can be gained only by experience and the closest observation.

As pointed out in discussing the soil, the amount of air it contains has an important bearing on the health and vigor of the plant. Water plays a very important part in this matter, for the more water there is in the soil the less space will there be for air. By the improper use of water, therefore, air is excluded from the soil and various complications are brought about, all of which directly affect the health, vigor, and productiveness of the plants. One of the results of the improper use of water in a soil naturally heavy is the formation in the roots of plants of alcohol and other substances destructive to growth. The roots in such cases are slowly suffocated, and the gradual decline and death of the plant is the result.

The improper use of water may affect plants in another way. The soil may be made a little too wet, and the air in the houses may also be oversupplied with moisture. These conditions are most likely to occur in winter. As a result of this certain changes are brought about in the tissues which make them more subject to the attacks of parasites, especially fungi, and also render them liable to other injuries, such as burning, scald, spot, etc.

Although not generally recognized, the method of applying water may have a decided effect on the growth of the plant by changing the structure of the soil, i. e., the arrangement of the soil grains and their relation to each other. It will be seen that the continuous and more or less forcible application of water to the surface of a soil on a greenhouse bench will have effects similar to dashing rains out of doors, that is, it will compact and puddle the soil and wash the smaller materials to the bottom, thereby changing its capacity for air, heat, etc., and thus directly influencing the development of the plant.

The soil should be kept open at all times to the free access of air. This may be done by keeping the surface stirred, by careful attention to watering, and, as is frequently done, by using a light mulch of manure or some suitable material to break the force of the falling water

The importance and necessity of a proper amount of heat and light in greenhouses are well understood. It is very often the case, however, that the smaller details in matters of this kind are overlooked or neglected, and the plants in consequence suffer. Different plants, as is well known, require different temperatures for their best development. These differences, as is also well known, vary not only with different varieties and forms of plants, but also with the different stages in the growth of the same. The plant in its relation to heat has been likened to a steam engine. When the tension of the steam is slight, the machine is barely able to overcome the friction of its own parts, and under such circumstances can do little or no work. As the tension of the steam is increased, the efficiency of the engine becomes greater and greater, until finally it reaches a point where the very best work is done. If the tension of the steam is increased beyond this point, the parts of the machine become strained, and the whole will eventually break down unless relieved of the pressure put upon it. In the case of a plant there is a point in the temperature barely sufficient to awaken the vital energies of the organism. With increasing heat the vital forces of the plant increase, until a point is reached when the best growth is made; beyond this point the plant suffers, and is eventually killed if the temperature continues to increase.

In considering the question of heat, the importance of soil temperature and its relation to the temperature of the air must not be overlooked. Unless the proper conditions are maintained in this respect, an ideal development can not be reached, and the plants, in addition to developing characters that make them unprofitable, are frequently made more subject to disease. A striking example of the latter is found in the case of lettuce when forced under glass. At certain stages of growth the plant in question is much subject to burn or scald, and for this reason it is often rendered wholly unfit for market. The burn is primarily brought about by the rapid evaporation of moisture from the leaves at a time when the roots are not able to supply the demand for water. The temperature of the soil has a marked effect on root action, and in this way the supply of water made available to the leaves is influenced. If the soil is cold, or, in other words, if the relation of its temperature to that of the air is improper, the roots can not furnish the water as fast as it is needed, and in consequence the tender tissues of the plant above ground simply collapse.

The value of light in the growth of plants is not always fully appreciated. It is a common occurrence to see plants which require strong light for their development struggling for existence in dark houses half buried in the ground. Within recent years, however. there has been a marked improvement in the manner of constructing greenhouses, and there is no doubt that the improvement in many of the crops now grown can be attributed to the recognition of the fact that properly regulated light is one of the fundamental factors in the growth of crops under glass.

It must be borne in mind that we can have rapid growth even in feeble light, provided the necessary heat and other necessary conditions are present. Such growth, however, is not accompanied by proper nutrition and, if continued, the plant finally grows itself to death. A familiar example of this is found in the case of a potato, which may sprout and grow in a warm, dark cellar, and yet so long as light is excluded there is little or no actual gain in weight. Light, therefore, is the energy which builds up the tissues, and unless it is properly regulated the plant will eventually suffer. Although light is exceedingly important in the development of plants, it may act injuriously if too intense. This is frequently seen in midsummer in the case of plants growing out of doors, where the foliage, exposed to the full rays of the sun, fade out and turn yellow, the whole plant having a sick, leathery look, the leaves being smaller and the branches more or less stunted. The same thing may often be seen in greenhouses, especially as spring advances and the light becomes strong. The necessity for properly regulating light by shading is here shown, but it is too often the case that proper judgment is not exercised in the matter. Remembering the role of light in the growth of plants, it will be seen that any attempt at lessening its intensity should be made gradually, so as to give the plant an opportunity to accommodate itself to the changed conditions.—(Y. B. 1895.)

Soil Sterilization.—The usual method of sterilization for greenhouse use is to build a large bin, about 4 feet wide by 10 or 15 feet long and 3 feet deep, running pipes through the bottom of the bin (or through the bin a foot from the bottom) a foot apart lengthwise. In a 4-foot bin there would be three pipes, with one-sixteenth inch holes drilled in them on the under side, about 1 foot apart. Fill the bin loosely with soil, turn in steam of about 80 pounds pressure, put a few potatoes in the top of the soil, an inch or so under the surface, then cover the surface with tight boards, burlap, or cloth, in order to prevent escape of the steam. Usually one or two hours under good pressure, if the soil is not too heavy, will cook the potatoes in the top of the soil; then one may be sure that the parasites and weed seeds have been destroyed. If high-pressure steam is used the soil will dry rapidly after the steam is turned off, and can be shoveled out of the bin without much difficulty, especially if one side of the bin is removable.

In sterilizing soil without the use of a bin about the same process is used. The pipes are laid in the ground to be sterilized in about the same manner as in the bin. If it is desired to sterilize about a foot of soil, the pipes should be placed under the soil about a foot, with the drill holes on the under side; the surface should then be covered with boards, burlap, or something to prevent the escape of the steam, and the soil should, of course, first be loosened, so that the steam can circulate through it. A few potatoes distributed over the area will tell when the sterilization has become complete. After the sterilization the pipes can be removed. It is a good plan before sterilizing to mix in the manure that is to be used, as this often contains numerous weed seeds. If commercial fertilizers are used, of course it is not necessary to add them first.

Any small high-pressure boiler will serve to make the steam. Some use a small independent boiler for the purpose; others attach the apparatus to their high-pressure boiler. A low-pressure boiler is usually unsatisfactory, as it takes a longer time to circulate the steam; it leaves the soil wet and soggy and does not do the work very well.

Soil sterilization is rapidly coming into favor for all intensive work where the process is practicable.

Three other methods of soil sterilization which have recently come into use in commercial greenhouse work have several points in their favor over the bin method described in this paper: (1) Steam sterilization by means of drain tile laid in the bottom of the beds, through which steam is passed; (2) also by means of an inverted pan under which steam is admitted, and (3) sterilization by drenching the soil with a formalin solution.

In the tile method of steaming, lines of 2-inch to 3-inch glazed tile are placed lengthwise in the beds to be sterilized, 2 to 2½ feet apart and 15 inches below the surface, and are left there permanently. They provide drainage for the beds, may be used for subirrigation, and are available at any time for sterilizing the soil, the only outlay of labor being the covering of the beds with boards or a tarpaulin and the connecting of the tile with a boiler by means of a piece of steam hose. The soil need not be moved, and thus a large part of the labor involved in sterilization is obviated. It is, however, advisable to spade the soil up so that the steam may more readily penetrate it. Another method of steaming by means of an inverted galvanized-iron pan, 6 by 10 feet and 6 inches deep, under which steam is admitted, has been used to a more limited extent in the sterilization of tobacco seed beds and also in greenhouse beds, and has given very satisfactory results. The use of steam at a pressure of 80 to 100 pounds and treatment for from one-half hour to an hour after the soil has reached a temperature of 100° C., as indicated by soil thermometers, has given the best results.

Formalin sterilization is accomplished by drenching the soil with a 1 to 100 or 1 to 200 solution of formalin, at the rate of three-fourths of a gallon per square foot of area, several days before the soil is to be used. Formalin, however, does not rid the soil of nematodes, as all the other methods do. This method has been used to good advantage in the sterilization of lettuce beds for Rhizoctonia.—(Reprint Y. B. 1902, 1910 Ed.)

Feeding Flowers with Commercial Fertilizers.—While it is perhaps safer to rely on organic or barnyard manures with bone and wood ashes to supplement them in phosphoric acid and potash, flowers can be grown without manures by the use of commercial fertilizers. Commercial fertilizers where used in connection with organic manures will first be considered.

It is safest to use quick-acting and easily soluble fertilizers like nitrate of soda, superphosphates, etc., in soils containing a good deal of fibrous material, leaf mold, or partially decayed vegetable fiber which will absorb the fertilizer and give it up slowly to the roots. In a compost made as described above, feeding with manure solution can be profitably alternated with commercial fertilizers. If the vegetative growth needs stimulating and brightening and the plants have strong root systems, give a feed of nitrate of soda—10 ounces to 50 gallons of water per 100 square feet of area. If the plants do not have strong, vigorous-feeding roots, and especially if the soil is not rich in fibrous material, use 6 ounces to 50 gallons of water. Continue at intervals of ten days to two weeks till growth is active and the foliage is of good, rich color. If growth is active and of good color but spindling and soft, the need of potash and lime is indicated and nitrogen should be avoided in this case. Potash may be supplied by giving a light coating of good wood ashes, 1 pound to 20 square feet of bench. Or if good wood ash is not available, sulphate or muriate of potash can be used, at the rate of 8 to 12 ounces to 50 gallons of water per 100 square feet of bench, at intervals of ten days to two weeks, or sprinkled dry at the same rate per 100 square feet. When either sulphate or muriate is used it should be followed after the second or third application by a sprinkling of lime, about 1 pound to 20 square feet. When the growth is plump and solid use only the ordinary manure water when needed. If the plants are growing well but are not making flower buds, cut down on nitrogen and give phosphoric acid either as steamed fine bone, free from salt, at the rate of 1 pound to 20 square feet; or, if it is desirable to avoid the nitrogen of the bone, give a dressing of superphosphate, 1 pound to 100 square feet, and follow in a few days by lime as above. The superphosphate may be applied in water, using 1 pound to 50 gallons of water for 100 square feet. If there is reason to believe that there is a general lack of plant food, a complete fertilizer should be used, alternating with manure solutions. Voorhees recommends one-fourth pound nitrate soda, 1 pound acid phosphate, and one-half pound muriate of potash for 100 square feet of area. Unless soil conditions are favorable and the roots strong, the amount mentioned is a little too high. A pound of the mixture per 100 square feet is safer. The amount of available water in a square foot of moist loam 6 inches deep (one-half cubic foot) is approximately 5 to 7 pounds (or pints), or for 100 square feet from 500 to 700 pints or pounds. At this rate 1 pound of material in solution in the 50 gallons of water (about 1 to 400) would add 4.8 grams (72 grains), or approximately one-sixth of an ounce to each square foot (6 inches deep). Counting the water in this amount of soil under the most favorable conditions for growth as 5 to 7 pounds per square foot of bed, there will be a soil solution (assuming that what is added remains largely in solution) of from 1 to 500 or 1 to 700. This is as strong as most plants will stand without more or less injury to the feeding roots. It is too strong to risk such very soluble and active materials as nitrate of soda, nitrate of potash, and muriate of potash, but is safer for superphosphates or sulphate of potash, as recommended above.—(Y. B. 1902.)

It is unsafe to use chemical fertilizers or liquid manures in full strength on a heavy soil which is not provided with sufficient fibrous material.

Stuart, of Indiana, recommends as a complete fertilizer for roses the following mixture: Superphosphate, 130 pounds; ammonium sulphate, 13 pounds; sodium nitrate, 31 pounds; potassium sulphate, 26 pounds. He recommends 1 ounce of this mixture to 1 gallon of water for 2 square yards of bench surface once a week as the plants need it. This is equivalent to 3 pounds to 48 gallons of water (approximately a barrel) applied to 864 square feet of bench surface, or about 6 ounces to 50 gallons of water for 100 square feet. This is the right strength for weak plants. Twelve ounces could be used to 50 gallons of water per 100 feet for strong plants once in ten days or two weeks, as the plants need it. It is safer to use the 50 gallons per 100 feet standard of application, as this is about the amount of water usually applied in an ordinary watering to 100 square feet of bed 6 inches deep.

Stuart has recommended the following as quick-acting plant food mixtures, differing only in the sources from which the food elements are obtained:

(I) Sixteen ounces nitrate of soda, 10 ounces potassium sulphate, 20 ounces disodium phosphate.

(II) Five ounces nitrate of soda, 20 ounces potassium nitrate, 20 ounces disodium phosphate.

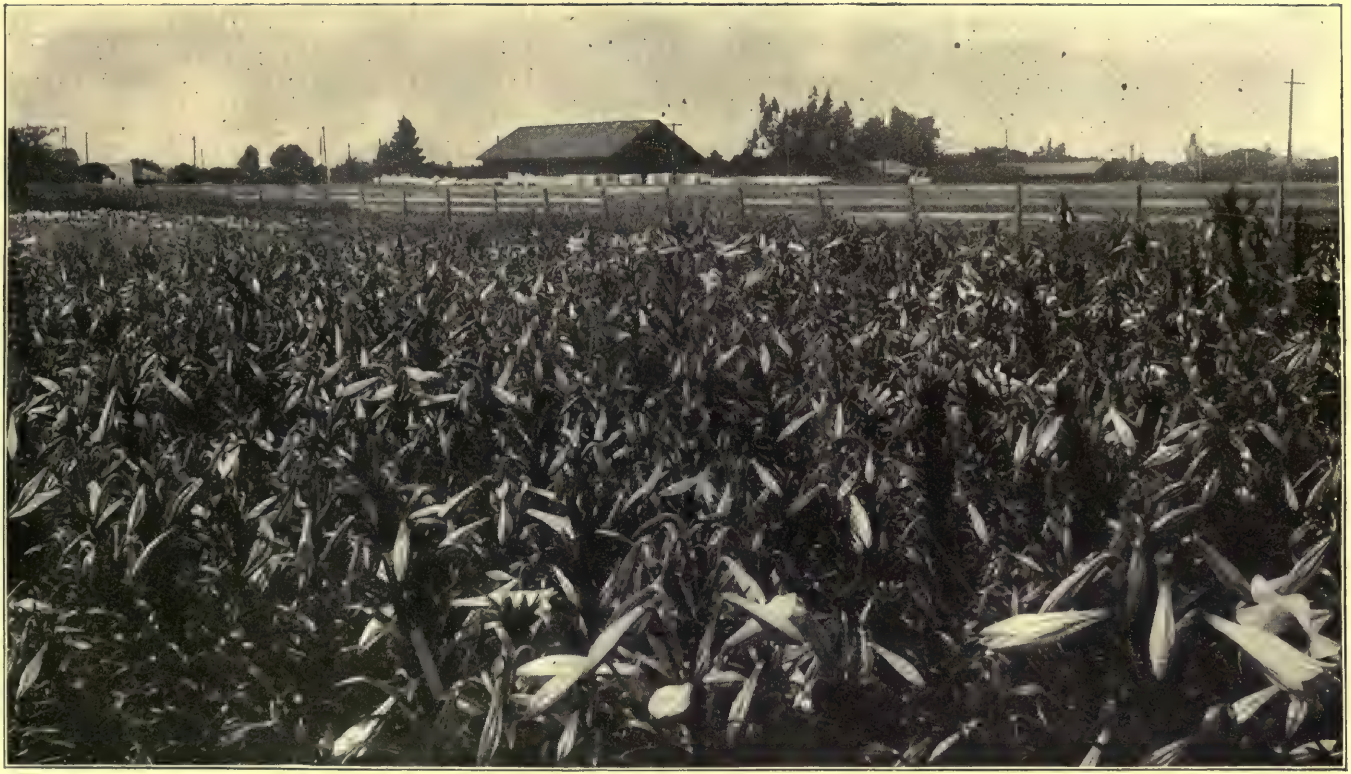
(III) Sixteen ounces nitrate of soda, 10 ounces potassium sulphate, 33 ounces acid phosphate, containing 12 per cent of available phosphoric acid.

Either one of these may be used at the rate of 8 to 12 ounces of the mixture to 50 gallons of water per 100 square feet of bench, the strength of the solution depending on the vigor of the plants.

Wagner's solution has given good results for roses as well as carnations and other crops. It is made as follows: Phosphate of ammonia, 2 ounces; nitrate of soda, 1¾ ounces; nitrate of potash, 1¾ ounces; sulphate of ammonia, 1 1-3 ounces; water, 50 gallons.

C. W. Ward, at the last meeting of the Society of American Florists, recommended some valuable formulæ for general use based on his own experience, and has given in a very concise manner the general principles governing their use.

Various other combinations of sources of nitrogen, potash, and phosphorus may be used at about the same rate of total soluble material for 100 square feet of bed 6 inches deep. The proportion of each food element must depend upon the need of the crop. It is necessary to consider the total soluble materials (salts), as well as the total available food, when figuring on the strength of solution to use. This is because, as previously explained, roots are often injured when the amount of salt in solution, whether food or other kind, exceeds a certain limit; that is, about 1 part by weight in 400 of water, for ordinary crops, though this varies more or less, according to the crop grown, nature of the salts in question, soil conditions, etc.



Field of Hybrid Seedling Easter Lilies, Calif. 12 Months After Planting.

If desired, the organic-manure solutions may be discarded and only chemical fertilizers used. Manure may also be left out of the soil and chemical fertilizers substituted. Voorhees recommends for forcing house crops in general when a good loam of reasonable fertility is used: One-half pound nitrate of soda, 1 pound acid phosphate, 1 pound ground bone, one-half pound muriate of potash. This is to be thoroughly mixed in the soil for each 100 square feet of bench at the time of filling, with subsequent feeding, as in the case of regular compost. He recommends for roses and other flowering plants where phosphates are especially desirable, 4 parts ground bone and 1 part muriate of potash, at the rate of 2 pounds of the mixture per 100 square feet of area, well worked into the soil previous to setting the plants. Later feeding may be followed as in regular compost soils.—(Reprint 1910, Y. B. 1902.)

Irrigation for the Greenhouse.—From the very nature of the case, plants grown under glass can not obtain a supply of water either from the clouds above or from the underlying soil, and if they are to maintain their growth it must be applied artificially. The common method of applying it through a hose or from a watering pot requires a man of experience and good judgment, as it is desirable to apply enough to moisten the soil without saturating it. Surface watering at the best packs the soil, thus preventing its proper aeration, promotes the development of slime and mosses upon its surface, and, particularly during the cloudy days of winter, keeps the surface of the soil in a damp condition, although the roots may be suffering from lack of water. In many cases, too, the water lodges in the axils of the lower leaves of the plants, and by keeping them moist promotes the development of the spores of parasitic fungi.

To lessen the labor of watering greenhouses, various sprinkling arrangements have been tried. Some of these consist of sprinklers that can be moved from point to point in the houses, while others are arranged at intervals upon pipes so as to water considerable areas at one time. While some of these arrangements may be labor savers, they have all of the disadvantages of surface watering; while the fact that all parts of the house may not require the same amount of water, and that unless carefully watched a surplus of water is likely to be applied, renders them impracticable.

Greenhouse Subirrigation.—Various methods of applying the water below the surface have been tried and for many crops have shown decided advantages over surface watering. The first attempt at greenhouse subirrigation was made at the Ohio Experiment Station, in 1890-91, with the hope of preventing lettuce rot. The result upon the growth of the plants was so marked that it was repeated upon a larger scale and with a variety of plants. Similar experiments have been tried and the results published by the West Virginia and the Michigan Experiment Stations.

While applicable to pot plants, it is generally used for those planted out in beds. These may be raised benches made of wood, or of iron supports with tile or slate bottoms, or they may be what are termed solid beds, resting directly upon the soil. In either case they should be practically water-tight. With wooden benches it is desirable that the supports should be close enough to prevent the sagging of the boards. The bottoms were formerly made of clear, matched lumber, laid in white lead, but for several years ordinary barn boards free from loose knots have been used at the Michigan Station. If these are laid close together and firmly nailed to the stringers to prevent their humping, they will, when wet, swell sufficiently to close the cracks. The writer generally lays the boards across the beds upon stringers running lengthwise of the house. To close the remaining cracks and to preserve the lumber it is well to coat the inside of the bed with a cement made of one part of water lime and three of sharp sand. This should be made into a thick paste and spread over the surface about one-fourth of an inch thick. For a bed with tile or slate bottoms a similar covering will render them sufficiently tight (fig. 52).

In case a solid bed is used, a tight bottom about 8 inches below the intended level of the bed is necessary. If the subsoil is stiff clay, it may be puddled and will then hold water, but it will generally be better to spread an inch or so of gravel and, after thoroughly ramming it, to place over the surface three-fourths of an inch of cement prepared as above. The beds should have sides of the same material 3 inches high.

The best way of distributing the water is by means of 2½-inch drain tiles, placed either lengthwise or across the beds at intervals of 3 or 4 feet. If the line is not over 50 feet in length, they may be placed upon a level, but for greater lengths the line should have a slope of 1 or 2 inches in 50 feet. To learn if the water is circulating properly, it is well to make an opening into the tiles once in 20 feet, into which a small flowerpot can be set. In laying the tiles care should be taken that the cracks between them are of an even size. As a rule, it will be found that they have become slightly curved in baking, so that the ends are not square, and if the convex sides are placed uppermost there will be a small opening at the under side large enough to allow the water to escape freely. If thought desirable, several lines of tile can be so connected at one end that they may all be filled from one hose, or faucets may be arranged so as to supply water in any desired amount to the different lines. The water can be admitted through sewer-pipe elbows, or by raising the end of the last tile so that it will show above the surface.

One-inch gas pipes with one-fourth-inch holes every foot have also been tried at the Michigan Station. While good results were obtained, the openings frequently became clogged and the water was not given off as freely as when tiles were used, so that a longer time was required to water the beds. Besides being cheaper the use of tiles seems in every way preferable.

In a general way subirrigation in greenhouses shows about the same advantages over surface irrigation as are found in the garden, but while the saving in time of watering and in the amount of water required is even greater in proportion, the direct benefits, especially reduction of time (10 to 25 per cent) required for maturing, are of still more importance.—(Y. B. 1895.)

PRUNING OF ORNAMENTAL PLANTS.

There are few ornamental trees or shrubs that do not require occasional pruning or trimming at one season or another for their best growth and development. The extent of this, with certain exceptions, however, is often quite limited, and in this respect ornamental plants differ from fruit trees. Pruning is usually given too little attention by the amateur planter and home-maker, with the result that the task is put off as long as possible to be finally disposed of with little or no forethought and regardless of results.

Some Reasons for Pruning.—All newly set trees should have their branches cut back to correspond with the loss of roots incident to transplanting, though this does not mean that such trees are to be reduced to poles. At planting time all mutilated parts of roots should be removed, and if the trees are of considerable size, *i. e.,* eight feet or so high, the main limbs should be cut back to within 12 or 14 inches of the trunk, the leader being, of course, retained. A sufficient number, varying with the kind of tree, of the more vigorous of these main limbs is left to form the framework of the crown. These should be disposed at nearly equal angles about the trunk, and not lie in the same horizontal plane. If handled in this manner, such trees as the ash, locust, mulberry, cottonwood, and sycamore will need little further attention for some years, and will usually develop into pleasing, symmetrical forms. When small trees are used, considerable pruning is often needed the first few years after planting on account of excessive growth induced through climatic conditions, cultivation, enriched soil, or extra water supply. This growth commonly manifests itself in water sprouts, over-development of the head causing top heaviness and leaning, or in extra growth in occasional vigorous branches in one part of the plant or another, all of which tend to destroy the otherwise natural form of symmetry of the tree, unless corrected by careful pruning. The much planted and justly popular pepper tree is a notable example of the above, due partly to its soft, yielding wood. On this account during its first years, cutting back and thinning out of the crown is necessary, in addition, to secure bracing of the trunk.

It is justifiable at times to resort to topping in the case of shade trees to induce a denser growth, or where trees have become too tall to be in harmony with their surroundings. Such pruning, however, should be done with deliberation as to effects desired. Dead or unhealthy branches or those broken by storms should be removed speedily, and if necessary the remaining top or crown reduced sufficiently to insure reasonable uniformity later. Slow growing or unhealthy trees are often encouraged to make vigorous growth by judicious pruning, in connection, of course, with other proper care. Open-headed trees may be made to grow more compact by heading in, while a gradual thinning out of the inner branches corrects trees with too dense or compact heads. Likewise, those that are non-symmetrical can be worked into symmetrical trees by removing the abnormal parts, though such treatment is most effective in the earlier training of the plant. As trees get older it becomes necessary to cut out some of the inner branches to open up the crown, thereby overcoming a crowded or brushy appearance, and providing for continued symmetrical development of the tree as a whole. The numerous dead limbs in the centers of even healthy trees are excellent witnesses to this fact.

How and When to Prune.—In all cases the cutting should be done close up to the trunk or branches and parallel to the surface of the bark, and the cut should be left smooth. Decaying projecting spurs are not only unsightly in themselves, but also retard healing over, and form excellent lodgment for fungous diseases. Hollow trunks commonly result from neglect of this character. The above is particularly true in the case of large branches, the removal of which leaves wounds of some considerable size. Late winter or early spring pruning is best for all ordinary purposes, as it induces an extra growth of wood the following season which is always desirable with ornamentals.

Large branches should not be removed just previous to nor during the period of most rapid growth of the tree as serious bleeding may result; neither should they be cut off in the late summer or fall, since a considerable period must elapse before healing-over of the wound can take place. In the removal of such limbs it is best to make two cuts, the first one 18 or 20 inches above the point where the final one is to be made. In this way danger from tearing the bark or otherwise damaging the trunk is overcome. After the first cut has been completed, which removes most of the weight of the limb, the final one can be made with ease and accuracy. Cutting first on the under side and then on the upper side of a large limb will usually secure the same result, though it is less certain. A heavy coat of thick lead paint, preferably of the color of the bark, should be applied to all wounds an inch or more in diameter. This not only improves appearances, but also renders such surfaces immune to fungus attacks and checking by weather.

Where one has but a few trees to attend, it is possible to handle them so as to make necessary the removal of only small limbs or sprouts, and the occasional pinching back of a branch that has outdone its neighbors. Trees cared for in this way are more uniform and symmetrical in their development, and make more rapid progress than others. In the case of trees or shrubs grown principally for flowers, those blossoming early in the spring season, like the locust, lilac, laurustinus and flowering quince, should not be topped or pruned until after flowering time, since such cutting would remove most of their blossom buds. On the other hand, those that flower late in the summer, as hibiscus, virgin's bower or clematis, and elder, should be pruned at the usual time, *i. e.,* in the early spring, since the blossoms of such species almost invariably develop on twigs of the same season's growth, and pruning at this time increases the number of these twigs.

Objects to be Attained in Pruning.—In the pruning of ornamental plants, in general, perhaps the most important consideration to be kept in mind is that of allowing the natural or characteristic shape of the variety of tree in question to assert itself, for the beauty of a particular plant lies in its individuality and distinctness from other plants. Of what consequence is it to set different varieties of plants about one's home and then proceed to make them look as much alike as possible by hard and fast cutting? In the case of trees of the same species one should select an ideal or typical specimen, and prune the others toward that end.

Ornamental pruning, therefore, should be directive or constructive, rather than destructive. Trees like the Lombardy poplar or Italian cypress that grow naturally upright should be encouraged in that habit, while those with graceful, spreading forms like the pepper should not be forced into artificial shapes by severe and continuous trimming and shearing, for all such attempts are certain to result in the end in aesthetic failure. Likewise one should not expect to make a tree out of a shrub, nor the reverse. In the extensive and interesting grounds at Del Monte, California, trees of most diverse forms and habits have had their individualities preserved to a remarkable extent by intelligent pruning, and this in spite of the fact that it was often necessary to do heavy cutting among the indigenous trees already growing on the grounds. In many instances one-fourth to one-third of a tree has been cut away without changing perceptibly its appearance, or that of the surroundings, so skillfully was the work done.

Coniferous evergreens such as cedars, cypresses, spruces and pines: Little pruning is needed by these plants at any stage of their growth. The limbs of the trunk should be left intact from the ground up, so as not to destroy the symmetry of the tree. Likewise, the central stem or leader should not be touched, and if by accident the terminal bud is destroyed, the most promising branch of the nearest lower whorl should be tied erect to take its place, and the remaining laterals of this whorl cut back or removed entirely to make certain its development into a leader. The occasional cutting back of limbs of evergreen should be done in the spring, since pruning at this season induces extra growth, and also encourages the development of new buds for further growth at the cut ends. Occasional lateral branches that make an extra strong growth may have their soft wood pinched back during mid-summer to preserve uniformity, or, if this is not enough they may be cut back in the spring to a strong bud. Evergreens should never be trimmed in the fall, and the older wood should not be cut.

Shrubs and Vines.—Shrubs like the oleander, privet, and myrtle, require pruning to remove dead or unhealthy growth, thin out and cut back the stems, overcome occasional straggly habits, and also to keep them within reasonable bounds in relation to their surroundings. They should be trimmed so as to have an easy and natural appearance, rather than a strict or artificial one. Ordinarily, they appear best when only the branches lying next to the ground have been removed. With roses, the stems should be shortened one-third to one-half. There is endless discussion concerning this, however, due in part to different conditions. The gardener's rule is to cut back the weak growing varieties severely, and the stronger ones less. In general, heavy pruning among roses encourages more vigorous growth with fewer and finer flowers, while the opposite treatment results in more flowers which are, of course, smaller and shorter stemmed. Vigorous growing vines, like the native Virginia creeper and the Arizona grape may have practically all the secondary growth cut away during the dormant season, as this dies of itself sooner or later, thus forming lodging for dust, insects, and sparrow nests.—(Ariz. E. S. Cir. 81.)

The Protection of Shade Trees.—Protectors are of three kinds. The young tree needs a support to hold its trunk erect and its roots in place against the soil; it also needs a guard to shield it from the bites of horses and other injuries to its stem; and it often needs a grill to prevent the trampling of the earth about its base and the consequent injury to its roots.

The support is usually a straight pole or joint ten to twenty feet long made of chestnut, spruce, oak or other wood set firmly in the ground next to the tree either on the south side, where it shields the stem from the sun, or in line with the row of trees, where it is least conspicuous. The tree is attached to its support in several places by means of iron, leather or cloth bands padded with cushions of wool, rushes, or other soft material to prevent abrasion. The support is removed at the end of the third or fourth year after planting, or when the tree is fully able to support itself.

The most common tree guard is an elongated box made of narrow boards which encloses the stem of the tree up to a distance of five feet or more from the ground. The box guard is easily made and very efficient, but clumsy and unsightly and affords an excellent retreat for insects. Wire netting is a cheap and excellent protector for trees and is now extensively used. In the case of young trees, it may be passed around the stem and nailed to the support; while on older trees it is usually attached to wire nails driven into the trunk. The best guards are made of iron. All guards of whatever kind should be fastened securely to the tree in such a way that no injury will result from rubbing; and, as the trees grow larger, care should be taken to loosen and enlarge the guards as the trees require.—(Cornell E. S. B. 205.)

GENERAL CULTURAL SUGGESTIONS.

Germination.—The germination of seeds depends upon a proper degree of heat, moisture, and air (oxygen). All three of these conditions must be present in normal proportions with each of the others in order to insure the best germination of the seed. Some seeds germinate best under a maximum degree of heat (80° to 90° F.) while others do best at a low temperature (40° to 60° F.). For most seeds, however, a soil temperature a few degrees higher than that of the surrounding air is desirable. A soil temperature of from 65° to 70° F. for an air temperature of 60° F. will prove very satisfactory for the germination of most seeds. It will be difficult to secure these conditions, however, without artificial means, such as a greenhouse, hotbed, or cold frame. Strange as it may seem, nature maintains conditions during the early part of the growing season approximating those above specified.

Moisture.—Seed in a majority of cases grow best when the moisture in the soil is slight rather than when present in excess. A good test for moisture is to take a handful of soil and compact it gently in the palm of the hand by closing the fingers. If when released the soil remains solid and retains the impressions of the hand, it is too wet; but if when released it springs back and slowly crumbles or parts, it is in ideal condition for seed sowing. Such soil is well aerated, while the soil containing an excess of moisture has the air largely replaced by water.

The seed bed should be carefully guarded against extremes of moisture. It should not be allowed to get too wet and remain in that condition for any length of time, neither should it be allowed to get too dry. In the open these conditions are not likely to occur during a normal season. However, there are frequent exceptions. If too wet, little can be done to overcome the bad results, but if drought occurs irrigation will remedy the evil. Under artificial conditions, such as obtain in a greenhouse, hotbed, or cold frame, the moisture content of the soil of the seed bed can be very carefully controlled. The confined atmosphere of such a structure prevents rapid or excessive evaporation, while any loss of moisture from the soil can be made good by watering. On a small scale the same results can be approached by placing a pane of glass over the receptacle in which the seeds are sown.

Soil Temperature.—Slight variations in the temperature of the soil in which seeds are sown are usually a benefit rather than a hindrance to germination. With the grasses and clovers germination is more rapid and more complete in seeds subjected to alternations of temperature than in those kept under constant temperatures. This applies to practically all seeds. Under normal conditions the warming of the soil during the day and the cooling at night furnish sufficiently wide variations. While these variations are less easily controlled than are the variations in moisture, yet in structures such as hotbeds and cold frames the change from day to night temperature will be perceptible.

The seed must be enabled to germinate and the soil is the medium by which heat and moisture are, under normal conditions, transferred to the seed. In order to insure a quick exchange of moisture from the soil to the seed the soil should be carefully firmed or compacted about the seed. By compacting the soil about the seed the capillary power of the soil is increased and as the seed becomes an intimate part of the soil the soil moisture is thus more quickly brought to the seed. In outdoor operations large seed may have the soil compacted about them tramping the row with the feet, while fine seeds may be treated by resting a board over the row and walking upon it from end to end. In hotbeds, greenhouses, and cold frames the compacting of the soil is usually accomplished by the use of a float, which consists of a piece of board about 6 inches wide and 9 or 10 inches long, with a handle attached.

For all conditions save in the open, seeds may be sown in seed pans or in flats, which can be very cheaply constructed. These boxes can be very conveniently made from the pine boxes largely used for packing canned goods, soaps, etc., usually 9 or 10 inches deep, which is sufficient to allow of cutting them with a ripsaw into three sections each about 3 inches high. The top and bottom of the box will each make a complete flat, while the middle section will be a frame which can be provided with a bottom by the destruction of a box for each three sections. Seeds may also be planted directly in the soil of the hotbed, cold frame, or in that upon the greenhouse bench. They may be sown broadcast or, preferably, in rows.

In covering seeds the rule under artificial conditions is to bury the seed to the depth of its greatest diameter. In outdoor culture, however, this is not the practice; seeds are usually covered about three to five times their diameter. With seeds the size of a grain of wheat it is, in general, safe to plant them 1 inch deep, and for those the size of beans 2 inches deep. Small seeds like those of petunia, tobacco, etc., should be scattered over the surface and the soil compacted with a float.

Transplanting.—The young seedling plants which are to be grown for their bloom should, as soon as the first true leaves are formed, be transplanted so that they will stand at some distance from one another. For small, rather slow-growing, plants, such as pansies, 1 inch apart each way will afford ample room, but with most plants 2 inches each way will be best, while with robust-growing plants, like the castor bean, 4 inches will not be too much. With such plants, however, it is best to place the seeds directly in pots or cans in order to prevent disturbing the roots of the young seedlings and to afford them ample space. Transplanting has a tendency to make the plants stocky and affords opportunity for the development of an extensive root system.

The pleasure derived from floral decorations depends not only upon the perfection of the flowers, but upon having a continuous display throughout the season. With most of the garden annuals early bloom can not be secured if seed sowing in the open must be relied upon exclusively. Fortunately the gardener's art has devised cheap and efficient means for, at it were, anticipating nature. By the use of cold frames in the South and hotbeds in the North the season can be advanced several weeks.

(*Additional References Consulted.*—F. B. 185; F. B. 195; Y. B. 1897; Nev. E. S. B. 61; Vt. E. S. B. 145; S. Dak. E. S. B. 64; Ariz. E. S. B. 85; Tuskegee E. S. B. 16; Nev. E. S. B. 24; Wyo. E. S. B. 50; Mich. E. S. B. 186; Mass. E. S. B. 147; Cornell E. S. B. 128; F. B. 185; B. P. I. B. 120; Cornell E. S. B. 147; B. P. I. B. 39; Md. E. S. B. 127; Md. E. S. B. 158; Minn. E. S. B. 38; Cornell E. S. B. 55; Cornell E. S. B. 96; Minn. E. S. B. 7; O. E. S. B. 43; Nev. E. S. B. 61.)

PART IV

OTHER FARM CROPS.

THE COTTON PLANT.

Cotton is the principal product of eight great States of the Union, and the most valuable money crop of the entire country. Climatic conditions practically restrict its cultivation to a group of States constituting less than one-fourth of the total area of our country, and yet the value of the annual crop is exceeded among cultivated products only by corn, which is grown in every state of the Union, and occasionally by wheat. Cotton furnishes the raw material for one of our most important manufacturing industries and from one-fourth to one-third of our total exports.

Considered without reference to any particular country, its economic importance is far beyond numerical expression; for while the total crop of the world is approximately ascertainable, the effect of cotton upon the commercial and social relations of mankind is too far-reaching for estimation. Of the four great staples that provide man with clothing—cotton, silk, wool, and flax—cotton, by reason of its cheapness and its many excellencies, is rapidly superseding its several rivals.

Cotton stands pre-eminent among farm crops in the ease and cheapness of its production, as compared with the variety and value of its products. No crop makes so slight a drain upon the fertility of the soil, and for none has modern enterprise found so many uses for its several parts. The cotton plant yields, in fact, a double crop—a most beautiful fiber and a seed yielding both oil and feed, which, although neglected for a long time, is now esteemed worth one-sixth as much as the fiber. In addition to this, the stems can be made to yield a fiber which waits only for a machine to work it, and the roots yield a drug. It is entirely possible, therefore, that cotton may ultimately be grown as much for these parts as for the lint.—(U. S. E. S. B. 33.)

Botany of Cotton.—Cotton (*Cotton Gossypium* spp.) belongs to the order *Malvaceœ,* which also includes okra and the hollyhock. The varieties of cotton cultivated in the Southern States belong to two species, upland cotton (*Gossypium herbaceum*) and sea-island cotton (*Gossypium barbadense*). Cotton was known to the ancient Asiatics and Egyptians, and was found growing wild in America by Columbus and other early explorers. It is therefore thought to be a native of both hemispheres. In its wild state, especially in tropical climates, cotton is a perennial shrub, but as cultivated in the South it is an annual plant. The cultivated cotton plant is a small shrub having alternate stalked and lobed leaves. The flowers of upland cotton are white or cream-colored on the first day, become reddish on the second, and fall on the third, leaving a small boll enveloped in the calyx. This boll develops until it reaches approximately the size and shape of a hen's egg, when it splits into three to five cells, liberating the numerous black seeds covered with the fibrous wood which constitutes the cotton of commerce. Formerly cotton was not grown north of the isothermal line 36°, but under the influence of phosphatic manures its cultivation in late years has been extended several degrees beyond this line. It is most successfully cultivated between 30° and 35° north latitude. Two periods in the life of this plant may be distinguished. The first extends from the time of planting, which in South Carolina is about the middle of April, to the middle of summer. This is the time in which the plant makes its growth of stalk and foliage and gathers nourishment, which will later be stored up in the seed. During this period tropical conditions are favorable, namely, moisture in the soil from frequent rather than long-continued rain, high temperature with small daily variation, plenty of sunshine, little wind, and a high relative humidity of the atmosphere to reduce evaporation to a minimum. During this period everything possible is done to prevent loss of water from the soil; grass and weeds are scrupulously excluded, and the surface of the soil is frequently stirred to conserve the moisture and increase the temperature of the soil.

In the latter part of the season in South Carolina the temperature rapidly falls and the rainfall diminishes. This is the fruiting period of the cotton crop, when every effort should be made to produce seed rather than stalk and foliage. Every means is taken to dry out the soil; cultivation ceases and the soil is allowed to become hard and compact to favor the evaporation of the moisture. It is believed that differences in moisture and temperature account for the fact that the fine grades of sea-island cotton can be produced only on the islands and in the country immediately adjoining the coast. —(U. S. E. S. B. 15.)

Varieties of American Cotton.—Two species of cotton are cultivated in the United States. These are American Upland cotton (*Gossypium hirsutum* L.) and Sea Island cotton (*Gossypium barbadense* L.). American Upland cotton, through misidentification, has been referred by American authors to *Gossypium herbaceum* L., but recent studies have shown conclusively that it is very distinct from the Asiatic cottons, of which *G. herbaceum* is a representative species. It is really more closely related to the Sea Island cotton. Both species cultivated in this country originatel in tropical America.

Sea Island cotton (*Gossypium barbadense* L.) yields a very fine, long, and silky staple, but can be grown commercially only in a limited area near the coast of South Carolina, Georgia, and Florida. Partly because of this narrow geographical range but more on account of the fact that breeders of Sea Island cotton have been working toward one and the same end—a still better staple—the species has not been split up into distinct types or groups of varieties.

Upland cotton (*Gossypium hirsutum* L.) forms more than 99 per cent of the cotton crop of the United States. The improvement of this species has progressed along several different lines according to the necessities or individual preferences of the grower, and very distinct types have been developed, such as the stormproof cottons of Texas, the early cottons of North Carolina and Tennessee, and the long-staple varieties of the Mississippi Valley. These diverse types have led some to consider Upland cotton a composite of different species, and a recent author intimates that no less than seven distinct species were concerned in its evolution.—(B. P. I. B. 163.)

Climate.—The following are the essential features of a climate adapted to the cultivation of cotton: The season must be sufficiently long for the crop to mature. One of the most important factors, therefore, is the probable date of the last killing frost in the spring and of the earliest frost in the autumn, for cotton has a very long growing period. Cotton picking is often extended far into the winter, but the first killing frost of autumn checks the active growth of the plant, and the blossoms or young bolls starting at this time will not develop into mature fruit. The crop requires six or seven months of favorable growing weather for its development.

The next most important consideration is the amount and distribution of the heat and rainfall. Cotton is a plant which thrives in a very warm or even hot atmosphere, provided the atmosphere is moist and the transpiration is not so excessive as to overtax the powers of the plant. The temperature should be high and the daily range uniform during the early growing period of the plant. The mean daily temperature normally increases from the time the seed is put in until about the first of August, after which it as rapidly falls, making two distinct periods in the life of the plant. During the first period of high and increasing temperature the plant should be in full vegetative growth. Any great and sudden range in temperature, or any prolonged cold spell, is liable to check the vegetative growth of the plant and tend to ripen it, which is very undesirable during this stage of development. By the first or middle of August the plant should have attained its full vegetative growth—that is, it should have stored up all of the food material it needs. From this time on a decreasing temperature and a greater range of temperature between day and night are favorable to the production of a maximum crop, for this checks the vegetative growth and induces the plant to convert the food material it has accumulated into fruit. The soil also should be drier during this second period.

As a rule the rainfall normally increases in the South from the spring to the middle of summer, when it decreases, and the climate during the autumn is usually remarkably dry and bracing. These conditions are favorable to cotton production. During the earlier period the rain should fall in frequent showers rather than in heavy storms, and the very best seasons are when these showers occur at night, giving with a large and well-distributed rainfall a large amount of sunshine.

These are the principal climatic conditions favorable to cotton production. They are gathered more from the experience of farmers than from the meteorologist, for the reason that the relations of climate to crop production are so involved and complex that it is impossible at present to give any adequate interpretation to the meteorological data and to show their full bearing upon crop production.—(U. S. E. S. B. 33.)

Soil.—The classification of soils into sandy, sandy loam, loam, clay loam, clay, and bottom lands has a very distinctive and important meaning to the farmer, for he recognizes certain properties characteristic of each of these classes of soils and has learned from experience to expect certain results.

On the light, sandy uplands the yield per acre is almost invariably small; on stiff clay lands and on bottom lands, especially in wet seasons, the plants are inclined to make an excessive growth of the leafy parts and to put on little fruit in proportion to the size of the plants and the crops to be late in maturing. It is also a recognized fact and a matter of wide experience that plants growing on some of these typical soils are much more subject to diseases and to insect ravages under unfavorable climatic conditions than on other soils. The safest soil for cotton is found to be a medium loam, although, as stated elsewhere, in favorable seasons and under favorable conditions very large yields are obtained from the heavier clay soils and on bottom lands.

The texture of the soils, therefore, or the relative amount of sand and clay, has an important bearing on crop production, as has been shown in the experience of farmers throughout the cotton belt. It remains to be seen what these differences are which are dependent upon the relative amount of sand and clay, which the farmer can recognize at a glance, as he can not recognize differences in the chemical composition of the soil.

The first thing which is very apparent in the consideration of this subject is that the character of the season, and especially of the amount and distribution of the rainfall, has a very marked and important influence upon the yield of cotton on all of these different types of soil. It is no unusual thing for a cotton crop on a heavy clay or rich bottom land to be so badly diseased or to be so injured by insect ravages as to cause an entire failure of the crop, or to be so delayed in maturing, by reason of unfavorable climatic conditions and rank vegetative growth, that the crop does not mature before frost. In more favorable seasons the yield from these same lands may be enormous. Every farmer also recognizes when he puts in his crop the great uncertainty as to the yield, and it is no uncommon thing for the yield of cotton for an entire State to be double one year what it was the previous year. It is likewise a matter of very common experience that the cotton in one field or tract of land will be much more affected by unfavorable climatic conditions than the crop in an adjacent field of perhaps a different character of soil.

Here is an indication of the great influence the conditions of rainfall and moisture have upon the cotton crop, and indications also that these different types of soil maintain very different conditions of moisture for the plants. It may be said, in fact, that while climatic conditions determine the general distribution of plants—make it impracticable, for example, to grow cotton in a northern latitude—the texture of the soils, or the relative amount of sand and clay they contain, and the relation of these differently textured soils to moisture largely determine the local distribution of plants and explain why some soils are adapted to cotton, wheat, tobacco, or to truck farming, and why other soils are not so well adapted to these crops.

As a rule, the relative amount of moisture maintained by different soils for crops under normal conditions depends upon the resistance the soil offers to the descent of the rainfall. The actual resistance, and therefore the relative amount of moisture, maintained by different soils depends upon the amount of space in the soils for the water to enter; upon the number of grains of sand, silt, and clay, for this will determine how much the space is divided up; upon how these grains are arranged, for this will have an influence upon the resistance or the friction the soil offers to the descent of the rainfall; upon the amount of organic matter in the soil, and upon the depth of the soil.

Soils contain, as a rule, about 50 per cent by volume of empty space; that is, in 1 cubic foot of soil there will be one-half cubic foot of space into which water or air can enter. In a sandy soil this space will not be divided up so much as in a clay soil; the sand having fewer grains the spaces between the grains are larger, so there is less friction and the water moves downward more quickly. These sandy soils will not, therefore, maintain so much moisture for the plants. The particles of clay soils, on the other hand, are so exceedingly minute, and there are such a vast number of them in the soil, that the spaces between them are exceedingly small and offer a great resistance to the descent of rain, so that the water moves very slowly and a large amount is maintained for the plants. A strong clay soil will usually contain three or four times as much water as a sandy soil, and this has a very important effect upon the growth of cotton.

Advantage is taken of this fact in greenhouses, but in nature, of course, the conditions cannot be controlled. In the latter case the amount of rain which falls must be taken, but different soils being so different in texture and in the resistance which they offer to the descent of the rainfall, maintain quite as different conditions of moisture as are supplied in practice under artificial conditions of greenhouse culture. Light sandy soils, being moderately dry, force plants to an early maturity, and these soils are used at present for the very profitable truck farming which has developed into such an important industry in recent years. Such soils are not adapted to wheat or grass, not necessarily because they are deficient in any particular food required for these crops, but because the dry conditions force the plants to an early maturity and the yield per acre is small. Clay soils, on the other hand, are adapted to wheat and grass, because they maintain uniformly moist conditions and the plants have a slow and prolonged growing period before it is time to mature seed. Clay soils are not adapted to early truck, because the crops are so late in maturing that they lose the advantage of the high market prices.

The resistance or the friction in the soil determines the proportion of the rainfall which will be held back for the use of plants, and determines largely the amount of moisture which different soils maintain. There must, however, be some automatic power to move this water from place to place in the soil and deliver it to the roots of plants as it is needed. This power exists in the soil in the force of surface tension, or, as it is more commonly called, capillary force, which may move water in any direction in the soil, either up or down or laterally.

Fertilizers have an important effect upon this force of surface tension. Lime, kainit, salt, plaster, and acid phosphate increase the surface tension and therefore increase the force which moves water to the plant. This probably explains many facts commonly met with in practice.

A cotton soil should maintain very uniform conditions of moisture, for any marked or sudden variation, especially during the growing period, is apt to affect the vitality of the plant and have a marked effect upon the development of the crop. During the early growing season of the plant, up to the first of August, the soil should be continuously moist, but not wet. A sandy soil, as a rule, is not sufficiently retentive of moisture, and the supply of moisture is so inadequate that the plants are small and are forced to an early maturity before they have gathered sufficient food material for a normal crop. On the other hand, a clay soil or a bottom land is liable to maintain too much moisture, and the plant takes on an excessive growth. If this condition is checked at the proper time and the plant is induced to mature fruit, the yield may be very large, but if this condition continues and the soil remains continuously moist after the first of August, the plants develop in a very luxuriant way, but with little tendency to put on fruit. Such soils may be greatly benefited by underdrainage, whereby the excess of water is artificially removed from the soil. This excessive growth may be checked also by fertilizers, especially by heavy application of phosphoric acid, which has a tendency to check the vegetative growth and hasten the maturity of the plant.

The safest soil for the cotton crop is a deep loam, naturally well drained, but sufficiently retentive of moisture to maintain a uniform supply throughout the entire growing season.

The following is Hilgard's description of the famous buckshot soil of Louisiana, which is justly claimed to be the finest type of cotton soil in this country:

The buckshot soil, in its store of plant food of all kinds, stands pre-eminent above all of the rest of the soils and well deserves its reputation of being the most productive and tillable soil in the great bottom. Unlike many other clay soils, it may be tilled at any time when the plow can be propelled through it, because on drying it crumbles into a loose mass of better tilth than many elaborately tilled upland soils. It is so deep that the deepest tillage, even by a steam plow, would not reach beyond the true soil material. Its high absorptive power secures crops against injury from drought. Two bales of lint per acre can be produced on these soils with fair cultivation and good seasons.

In South Carolina the ridge lands and the soils of the Red Hill formation, covering an extensive area in the central and eastern portions of the State, are types of the most productive and most certain cotton soils, under good treatment. These soils, which may be considered a type of the finest cotton soils of that region, contain from 25 to 30 per cent of clay and 40 per cent of silt. In the North this would make a very fair quality of wheat land. These soils maintain on an average during the growing season about 10 or 12 per cent of moisture for the cotton crop.

The Sea Island cotton is best adapted to a very different kind of soil. The best soils for this variety are light, fine-grained, sandy soils, containing from 4 to 8 per cent of clay, from 4 to 6 per cent of silt, and from 75 to 90 per cent of fine sand. Soils of this character from James Island maintained during two growing seasons about 5 per cent of moisture and are very different from the best type of soils adapted to the upland cotton.—(U. S. E. S. B. 33.)

Fertilizing.—In reviewing the results of the experiments conducted at or under the auspices of the experiment stations, and taking into account the general experience of successful cotton growers, certain general conclusions on the subject of the fertilization of cotton may be accepted as tentatively established:

(1) Cotton is a plant which responds promptly, liberally, and profitably to judicious fertilization.

(2) By judicious fertilization the maturity of the crop may be hastened and the period of growth, from germination to fruiting, so shortened as to materially increase the climatic area within which cotton may be profitably grown.

(3) As is the case with most other crops, the profit from manuring cotton with concentrated fertilizers is much enhanced by antecedent proper preparation of the soil. It pays to bring cotton lands up to a condition of good "tilth" by mechanical treatment, and especially by incorporating in them liberal quantities of organic matter. Upon lands in such condition fertilizers of all kinds yield more profit, either from small or large applications, than upon lands not so treated.

(4) Renovating crops, and especially the cowpea, furnish an efficient and economical method of bringing cotton lands into condition to respond most liberally and profitably to the application of concentrated manures under cotton. The most profitable plan of employing the cowpea for this purpose on cotton is to gather the peas at maturity, cut the vines for hay, and turn under the stubble along with the manure resulting from feeding the hay to stock and cattle.

(5) Barnyard manure and similar bulky manures are more efficient and profitable as soil renovators than as specific fertilizers for cotton. They should be broadcast liberally and used rather as soil improvers than as immediate fertilizers. The same is probably true of cotton seed, except where the price to be had for the seed at cotton-oil mills justifies the exchange of seed for cotton-seed meal, to be used as the source of nitrogen in a concentrated manure. If, however, only small quantities of such manures are to be had, and it is desired to use them as direct fertilizers, it is more profitable to compost them with acid phosphate (preferably containing a small percentage of potash) than to use them alone. It is more profitable to compost directly in the drill at time of planting than in heaps previously.

(6) Cotton may wisely be assigned a place in a judicious rotation system. Upon lands devoted to staple crops a three years' rotation—small grain, corn (with peas), cotton—is judicious. Each crop in the rotation should be appropriately fertilized. It is in evidence that the cumulative effects of such manuring upon the succeeding crop are marked.

(7) Upon the great majority of the soils of the cotton-growing States it is advisable and profitable to use, as a concentrated fertilizer, a "complete manure," i. e., one containing soluble phosphoric acid, available potash, and available nitrogen, rather than a manure containing only one or two of these ingredients. Nitrogen, however, may probably be advantageously omitted from the concentrated fertilizer, in whole or in part, when the soil has previously been liberally supplied with this ingredient, through barnyard manure, green manuring, etc.

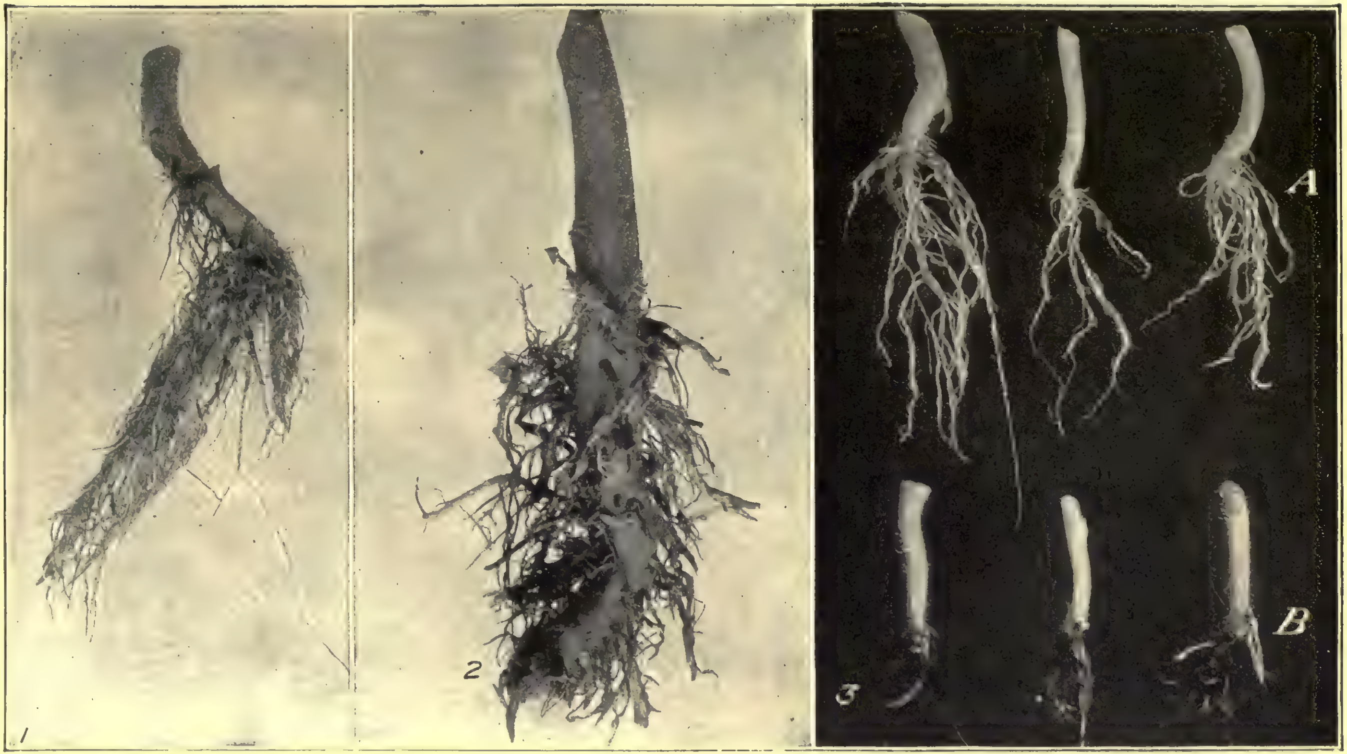
(8) "Soluble" phosphates are very much to be preferred in the fertilizer for cotton to those which are not soluble.

(9) There is no great difference, if any, in the agricultural value and profit, when used in the fertilizer for cotton, of the various soluble potash salts to be had in commerce, except proportionately to the price and content of actual potash.

(10) Of the nitrogen compounds available for use in fertilizers the organic forms (vegetable and animal) are perhaps best suited to cotton, if one form alone be used, although nitrate of soda is probably nearly if not quite of equal value. Further experiments are needed to determine the efficacy of mixing various nitrogen compounds in different proportions.

(11) The most judicious proportions of soluble phosphoric acid, potash, and nitrogen in a complete fertilizer for cotton can not be said to have been as yet determined with entire accuracy. Those suggested by Georgia—nitrogen 1, potash 1, phosphoric acid 3½—and by South Carolina—nitrogen 1, potash ¾, phosphoric acid 2¼—perhaps approximate reasonable accuracy. In the light of present information, perhaps nitrogen 1, potash 1, phosphoric acid 2¾ or 3 would not be injudicious proportions for general use.

(12) The amount of concentrated fertilizer which may profitably be used per acre varies widely with the nature and condition



Tobacco Plant Affected with Root Rot. 1. Inoculated at Two Months. 2. Diseased Root from Fields. 3. (*A*) Sterilized with Formalin. (*B*) Untreated. Dept. of Agr.

of the soil, the seasons, and other circumstances. For an average soil in fairly good condition perhaps the maximum amounts indicated by Georgia (nitrogen, 20 pounds; potash, 20 pounds; phosphoric acid, 70 pounds), or by South Carolina (nitrogen, 20 pounds; potash, 15 pounds; phosphoric acid, 50 pounds), or an approximate mean of the two would be the maximum limit of profitable application. The actual weight of the complete fertilizer furnishing these quantities would, of course, vary with the percentage composition in nitrogen, potash, and phosphoric acid of the materials used to make the fertilizer. If the commercial "ammoniated" fertilizer or other concentrated manure intended for use under cotton should be compounded (as it might very well be, and in some cases is) to analyze approximately—

	Per cent.
Soluble (available) phosphoric acid	9
Potash	3
Nitrogen	3

then 700 pounds per acre of such a fertilizer would be approximately the maximum amount that could judiciously and profitably be used, under ordinary circumstances, upon soil in good condition.

(13) The concentrated fertilizer should be applied in the drill (not broadcast) at a depth of not more than 3 inches, and well mixed with the soil.

(14) All things considered, it is perhaps best in most cases to apply all the concentrated fertilizer in one application at the time of planting. With lands in superior condition, however, or where large quantities of fertilizers are used, it is probably profitable to apply half at planting and half at the second plowing.

Methods of Manuring Cotton.—The method of fertilizing for cotton at present employed by the Southern cotton grower varies somewhat with differences in soil, climate, capital, etc. The greatest variation, perhaps, is in the preliminary preparation of the land. Some cotton farmers practice green manuring, rotation, composting, etc., with regularity, others irregularly, others not at all. There is much greater uniformity observed in the use of concentrated fertilizers, although here, again, there are wide differences in usage, particularly as to the amount of fertilizer employed. From the time of their introduction until the present, the method of applying chemical manures to cotton has been essentially uniform and the same, viz., in the drill. They are very rarely broadcasted. Neither, indeed, as a rule, are composts, stable manure, or cotton seed. A shallow furrow, varying in depth from 3 to 6 inches—much more frequently 3 than 6—is opened with the plow and the manure applied by hand (generally through a tin tube, known as a "guano horn," 3 feet long and 2 inches in diameter) or by a mechanical "distributer," much like a grain drill planter and capable of being set to deliver fixed and uniform quantities. The manure is then "listed" on, i. e., covered with a thin layer of soil to the depth of 1 to 3 inches. The seed are dropped upon this, either by hand or from a "planter," and covered with soil to a depth usually of 3 inches. The seed are frequently rolled in ashes, or sometimes in acid phosphate or other fertilizer before planting. The amount of fertilizer used per acre varies greatly. From as little as 50 pounds to as much as 1,000 pounds per acre is used. The average amount used by the very great majority of cotton growers is probably between 175 and 200 pounds per acre. The fertilizer is for the most part the commercial "ammoniated" article, although considerable quantities of acid phosphate (with or without potash) and home mixtures of chemicals are so used. In the case of composts, such as that prepared by the "Furman formula," for example, the amount used is usually about 400 pounds per acre.

The commercial ammoniated fertilizer sold in the Southern States at the present time will average in composition, approximately—

	Per cent.
Soluble (available) phosphoric acid	9
Nitrogen	2
Potash	2

Acid phosphates range in content from 12 to 15 per cent of available phosphoric acid, and are often given a small content of potash, ranging from one-half of 1 per cent to 2 per cent.

The home mixture of chemicals is usually constructed on the formula approximately—

	Pounds.
Acid phosphate	1,200
Cotton-seed meal	600
Kainit	200
	2,000

At the time of planting it has been found an excellent practice to apply a few pounds of readily soluble fertilizer directly in the furrows with the seed. For this purpose a portion of the fertilizer intended to be bedded on may be reserved (say 40 to 50 pounds per acre); but nitrate of soda has been found most convenient and effective and it should be applied at the rate of 25 to 40 pounds per acre. The effect of this small dose of quickly soluble and immediately available nitrogen is to cause the young seedlings to be very strong and vigorous on their first appearance, and to grow more luxuriantly during the first few weeks after planting, enabling the farmer to commence the work of cultivating and thinning to a stand some days earlier and with more confidence. The experience of a good many years justifies a strong indorsement and recommendation of this simple detail. The nitrate of soda may be applied by strewing it along behind the planting machine either immediately or within a day or two. No covering is necessary.

A crop so re-enforced and encouraged at the very start will be more likely to escape injury from plant lice, cutworms, and the like, and the more vigorous young plants will be able to resist the effects of rough or careless working. In the early history of the use of commercial fertilizers (mostly imported guanos), it was a favorite expedient of the writer to roll his planting seed in Peruvian guano, first thoroughly wetting the seed and using the fine, dry guano as a drier. For this purpose 6 pounds were found to be ample for 1 bushel of seed. Not the slightest injury to the seed ever resulted from the practice; but the dark green, vigorous appearance of the plantlets was most remarkable. It was a good practice, resulting in great saving of planting seed—a desideratum when seeds of a desirable variety are scarce and high priced—as well as in securing a good stand of vigorous, healthy plants.

A simple, easily constructed machine for "rolling" the seed may be made in an hour by any carpenter: Take an ordinary iron-bound whisky barrel. From the middle of one side, saw out a square hole extending across two or three of the staves, or, say, 10 or 12 inches square. Batten together the pieces sawn out so as to form a shutter for the opening, and fasten with thumb buttons. Run a 2 by 2 inch wooden axle through the center of the heads, with a common winch at one end; mount the barrel like a grindstone, on two posts set in the earth. To operate it, put in 2 bushels of cotton seed and an ordinary pailful of water. Turn the barrel slowly back and forth a few minutes until every seed is wet. Let the superfluous water drain away for a half minute. Then add about 12 pounds of any suitable fine, dry powder, such as Peruvian guano, land plaster, slaked lime, road dust, or sweepings from beneath a house. Turn the barrel back and forth slowly a few times and the seed will be found ready to plant, every one to itself.—(F. B. 217.)

Rotation of Crops.—A rotation has been defined as a plan in which a recurring series of different annual crops are grown upon a given section. Investigators have found that various crops not only require but absorb different quantities of the inorganic constituents from the soil; hence if a given crop is grown continuously for several years the special elements required by that plant may become depleted.

By rotation of crops several purposes are accomplished, as follows:

(1) The productive capacity of the land is increased and maintained. The cultivation of cowpeas, velvet beans, and other legumes adds to the soil large quantities of nitrogen drawn from the air, enabling the farmer to secure at slight expense an element which is the most costly part of purchased fertilizers.

The physical condition of the soil is improved, especially by the addition of humus or vegetable mold, whereas continued cultivation in cotton or corn rapidly exhausts the humus. The importance of humus can hardly be overestimated. A soil rich in organic matter is more easily cultivated than other soil. It suffers less from washing because the water is absorbed, and because of this water-holding power it does not quickly become too wet, nor does it dry quickly; hence, injury from drought is lessened. A soil rich in organic matter is richer in the beneficial bacteria and other organisms that take part in rendering available to the plant the food hitherto locked up.

By rotation, crops with different fertility requirements are alternated so that the same elements are not drawn on so constantly. Cover crops which increase humus can succeed cultivated crops which exhaust it, and in the intervals of rotation any poisonous or injurious excretion from the roots of a crop is neutralized. Deep rooted crops may be employed to bring up plant food from the subsoil and leave it at the surface when they decay, where it will be available for shallower rooted crops. The test of successful farming is to produce large and profitable crops and at the same time to build up the fertility of the soil, making it each year more productive. Diversified farming permits this to be done; continuous cotton growing never will.

(2) A diversified cropping system places farm operations on a safer and more economical basis. Regular and continuous employment for labor is secured if crops are grown which require attention at different seasons. The danger of loss from unfavorable weather or glutted markets is much diminished when several crops are grown. It is particularly important that the growers of Sea Island cotton should begin at once to practice diversification in order to gain experience with other crops, because there is a possibility that the invasion of the boll weevil into the eastern States may in a few years make Sea Island cotton an unprofitable crop. Much hardship will result unless other crops are established meantime.

(3) Rotation of crops is one of the most effective means of controlling weeds, insects, and plant diseases. Crab-grass, nut-grass, and other weeds troublesome in cotton fields are reduced in numbers by the shading and smothering effect of a heavy growth of cowpeas or velvet beans. Most injurious insects and plant diseases attack only one kind of plant. The continuous culture of any crop affords ideal conditions for the multiplication of its pests, while rotation of crops results in their destruction from lack of food.

For example, the nematode worm, causing the destructive root-knot of peaches, cotton, etc., is greatly increased by planting susceptible crops, but can be controlled by a succession of immune crops, such as corn, oats, velvet beans, or peanuts. For several cotton diseases, including anthracnose, boll-rot, and "black-arm," rotation is advised as one of the several preventive measures.—(F. B. 302.)

Cotton Culture.—As a general rule the soil should be plowed at least three months before the time when the cotton seed is to be planted. Cotton requires a firm, well-settled seedbed, and unless the plowing is done early, this condition cannot be secured. The depth to which the soil should be plowed will depend somewhat upon the previous treatment of the field. In cases where shallow plowing has been practiced, it is not advisable to make any radical change the first season, and in working down to a greater depth a small increase should be made each season. This year the soil is turned to a depth of four inches, another year one inch can be added to this furrow, and similar progression can be made until the necessary distance is reached. A material change in the depth to which the soil is turned would bring a large supply of inert material to the surface, and the supply of available plant food in the upper layer of soil would be limited. Shallow rooted crops, like the cereals, would scarcely make a maximum growth on the inert sub-soil. Cotton sends down a long tap root, and it would scarcely receive as severe a check as wheat or oats; however, the seedbed should be placed in an ideal condition for the more vigorous growing plants. As soon as the field is plowed, the surface should be harrowed down thoroughly. In some sections farmers make a practice of listing their cotton ground quite early in the spring, and about a month later the field is re-listed and planted. During wet seasons cotton which is planted in a listed row may be placed at a disadvantage on account of the moisture. On sandy fields such a plan affords some protection where the soil has a tendency to blow. From a quarter to one-half bushel of seed appears to be the proper amount to use in planting.

Tillage, or cultivation, has a two-fold object; first, it breaks up the surface soil and in forming a mulch prevents the evaporation of moisture; and secondly, it keeps the land free from weeds. The latter plants are objectionable in that they consume large quantities of moisture and plant food, hence the supply for the useful plant becomes limited. Surface cultivation should be given as soon as the cotton is large enough to permit the operation. There are cases where the harrow or weeder could be used to good advantage before plants make their appearance. Heavy showers frequently occur immediately after planting and a thick crust forms upon the surface of the field. This crust may become firm enough to prevent the young cotton from reaching the surface. A stroke with a smoothing harrow will aid these plants in breaking through, and the light mulch formed will also tend to conserve moisture for future use. As soon as the plants are up nicely, the surface soil should be stirred thoroughly to a depth of one or one and one-half inches. A spring tooth cultivator or an implement that has five or more teeth arranged in each section will do more effective work than a machine which has but two or at most three shovels on each section. The large, heavy shovels roll the earth to some extent and unless some care is exercised the young plants may be covered with the moving soil. Some cotton growers recommend the use of the cotton sweep for the first cultivation. It is true that this implement is very effective in cutting off and destroying weeds which come up in large numbers early in the season, but it does not pulverize the surface sufficiently to form a good dust mulch.

When the cotton plants commence to show the third leaf, the crop should be thinned to a proper stand. This work can be carried out best by the use of the hand hoe. Cotton chopping machines have been placed upon the market within recent years. New devices are being added from time to time, with the assurance that when the respective types have been perfected, the cotton grower will be able to thin a much larger area within a given time than by following the old method. Good results have been obtained on upland soil by thinning to a stand of one plant every fifteen inches in the row where the rows are forty-two inches apart. The proper distance in the row can be gauged approximately by the eye where the work is done by hand and the chopping out or "blocking" can be done quite rapidly. It is a good plan to leave vigorous plants, having only a single plant in a place. Better results will be obtained by thinning early than by allowing the full row to make a strong growth before the field is blocked. In the latter case the extra cotton plants may be considered as weeds for they take up moisture and plant food which should be kept in store for the plant which will produce the crop. Early thinning insures a stronger growth in the plants which are allowed to remain. Any weeds in the row can also be cleaned out at the time of "blocking," and if the work is done carefully it will probably not be necessary to use the hand hoe again during the growing season. If a few weeds appear and it is impossible to reach them with the cultivator, they should not be allowed to go to seed but should be cut with the hoe or pulled up by hand. One noxious weed may furnish enough seed to get the same crop well started over the entire farm.

The culture, subsequent to the "thinning out," should be frequent and thorough. One writer states that "once a week and once to the row with a good horse cultivator is an excellent rule." However, it may not be possible for the man who has a large acreage devoted to hoed crops to cultivate the cotton crop each week; at the same time, plans should be laid to make the cultivations as frequent as once in two weeks. This treatment should be given up to the time when the plants commence to bloom, or at least until the ground has become well shaded. A single horse cultivator can be used after this period to stir the surface, but some care will be necessary in order to prevent the implement from knocking off the blossoms. These early blossoms produce the early crop of cotton. It should also be noted that excessive culture at this particular period will have a tendency to cause the plant to produce an abundant growth of stalk, or to use the cotton growers' phrase, "It will encourage weed development." It will also have a tendency to cause "shedding" or dropping of the fruit. This is not a desirable feature, especially where an early crop of cotton is the object sought.—(Okla. E. S. B. 77.)

If an early crop of cotton is desired, (1) Prepare the soil thoroughly and early, beginning with fall plowing; (2) fertilize liberally and judiciously, carefully avoiding an excess of nitrogen. On rich, dark, alluvial, and freshly cleared soils, phosphoric acid alone, in the form of acid phosphate, may be applied; (3) apply fertilizers in the drill and bed on them. Broadcasting is rarely, if ever, expedient. (4) choose an early maturing and productive variety of cotton, and plant on the beds, and as early as possible. Apply in the seed furrows 40 to 75 pounds per acre of quickly available fertilizer, preferably 25 to 40 pounds of nitrate of soda; (5) reduce to a final stand as quickly as possible; (6) let cultivation be frequent and shallow; (7) narrow rows with wide spacing of plants in the rows will result in a greater early yield than will wide rows with close spacing.—(F. B. 217.)

Bedding up land previous to planting is universally practiced. Where manures are drilled in, this is indispensable. It forms a warm seed bed in the cool weather of early spring and possesses other advantages. The plants are usually left 2 to 3 inches above the middle of the row, which in 4-foot rows gives a slope of an inch to the foot. This causes the plow in cultivating to lean from the plants, to go deepest in the middle of the row, and, as a consequence, to cut fewer roots.

Four feet is the usually accepted distance between the rows. The distance between the plants seems of little importance within the limits of 8 to 14 inches. Still, as nothing but cotton stalks will make cotton, it is unsafe on average land to risk wider spans than 1 foot. Nothing conclusive has been settled about checked cotton. It may save a hoeing, and as plowing is done at about the same cost the question of saving is not determined. The skillful use of the hoe does the most accurate and thorough work. Good crops are made with the hoe without using the plow at all. It may be said that cotton growing was originally established entirely by hoe culture, even the soil for planting being prepared with the hoe.

The perfect cotton planter is not yet invented. It should drop five or six seed in a single line at regular intervals, say a foot apart. In very dry seasons a narrow and deep coulter furrow, the dirt closing in behind it, is run immediately in advance of the planter. It freshens up the bed and assists very much the germination of the seed.

Much is said about deep and shallow culture, and many believe that they can affect the plant beneficially by practicing the one or the other. The only certainty is that all grass and weeds must be vigorously kept down, and that the capillary pores, through which the moisture escapes after rains, must be broken. The first is most thoroughly effected by a broad, sharp sweep, which takes everything it meets, while going shallower than most other plows. Harrows and cultivators are apt to be turned aside by stubborn bunches of grass, which thus escape them. But the sweep does not distribute the loose dirt as generally as a light harrow does and therefore is not as effective in the mulching process. The effect of cutting roots depends entirely upon the season that follows the operation.

General Observations on Cotton Culture.—The matter of the first consideration in the culture of cotton, as in that of any other crop, is to prevent the removal of the soil by washing. Everywhere in the hill country neglect in this regard has resulted in the denudation of the soil from extensive areas of cultivated fields, rendering them barren, and devastating other fields lying at a lower level. Nor does the injury stop here. The public roads become convenient channels along which, to their destruction, these muddy floods at last pour into the streams, damming them up, causing freshets, and converting fertile bottoms into miasmatic marshes. The evil is generally recognized, and to some, but to a wholly inadequate extent, remedies are applied by terraces and hillside plowing. Where this is thoroughly done, and persisted in, it has proved eminently successful. A very common error, has, however, attended the practice. It is that some fall should be given the line of the terrace, to allow the water to escape. The result is, that while one gully may be cured by such a terrace, a larger amount of water is concentrated at its lower terminus, and another and larger gully created there. The terrace should be on an exact level, and must from time to time be amended, on account of changes occurring in the spaces between the terraces. A spirit level may be used to establish the line of terrace, but a simpler, cheaper, and more accurate implement is a compass, made of light stuff, and strengthened with a crossbar. The legs should be 15 feet apart at the ground, coming together 7 feet above it. At the apex a cord is suspended, with a weight attached to act as a plumb bob. When the feet are on a level, the place where the plumb cord crosses the bar is marked. In stepping off the terrace the level will be exact when the plumb line corresponds with the mark on the crossbar. It would seem proper that legislation should compel owners on the higher levels to restrain the rains, which, falling on their fields, issue in destructive floods on their neighbors' at a lower level.

Drainage.—The usual substitute for drainage in the cotton field is putting the plants on a high bed and cultivating them deep. It is an expensive substitute, and the rice and sugar planters along the border of the cotton illustrate with ample object lessons the benefits and methods of drainage. The trouble is that the original outlay for drainage is considerable, while the makeshifts, though in the end more costly, are within the reach of the small cultivator.—(U. S. E. S. B. 33.)

Seed Selection.—When the harvest season arrives, plans should be made to carry out some systematic work in seed selection. Vilmorin has made the statement that selection is the surest and most powerful instrument that man possesses for the modification of living organisms. Possibly no other plant will respond more readily than the cotton plant where judicious selection is made a matter of careful study on the part of the cotton grower. Useful characters only should be considered. It would be preferable to single out one desirable characteristic and endeavor to establish or fix that particular quality in the plant, rather than attempt to develop three or four characteristics at the one time. In selecting plants from which to obtain seed, there are several important lines of work that can be taken into consideration. The practical farmer will look for a variety that will produce a maximum amount of seed cotton per acre, but productive capacity is not the only item which should be chosen. With many varieties an increased length of staple or greater uniformity of fiber would be highly desirable. Furthermore, the quality of the fiber could also come in for improvement. Other varieties again are backward in maturing and as earliness is a desirable feature some attention could be directed to the selection of seed from plants which are much above the average in this respect. Soil and climate are factors that have to be considered when the selection of a variety for a given locality is made. Plants can be selected as well with reference to their disease resistant qualities, thus it becomes possible to raise good crops in sections where failure has resulted owing to the existence of some fungous disease. Again, careful observation will lead to the conclusion that there is a marked difference in varieties with regard to the manner in which the cotton is retained in the boll, hence there is room for improvement of the storm resistant qualities of most of the varieties which are grown at present.

The field should be carefully inspected and a number of plants which show marked superiority labeled. Each plant should be assigned a definite number so that exact information may be obtained when the entire crop for the season has been picked. In separating the best plants from the inferior grades, there are three or four items which should be given some prominence in the comparisons that are made. It has already been intimated that productiveness is a prime requisite, hence a plant containing a large number of well formed, good sized bolls should be taken in preference to the plant which contains only a medium number of bolls. "Like begets like" is an old well-established law and it would be proper to expect seed from the prolific plant to produce plants with like characteristics. A vigorous, well shaped plant should always be selected, since a plant of this description will carry a larger number of bolls than a plant which lacks in this respect. The earliness of maturity can also be ascertained at the time of selection. It would be well to select more plants than will be used for the reason that some of the individuals may fail to come up to the required standard.

After plants are labeled and numbered, small sacks with corresponding numbers should be provided so that the product from each individual plant may be kept in a separate sack. The earliness of the various plants can be determined by weighing the respective pickings as they are taken during the fall. A few notes and measurements may be made during the fall, and these in turn can be used for reference in making further comparisons. This part, however, is not absolutely necessary, but the suggestion is made so that any who wish may follow the work through minutely. When the entire crop has been picked, the product from each individual should be weighed accurately and recorded. A careful comparison of these weights will enable one to select the best individual plant, or the best six plants in the list. The cotton can then be ginned, but scrupulous care should be exercised to see that no mixing occurs. It is a very easy matter to get a few inferior seeds from some outside source mixed with the pure lots. Return the pure seed to the respective sacks, and make sure the proper notes and numbers are recorded on each, and store the same in a safe place for the winter. In the spring a special piece of ground, and it may be added here that the soil should be representative of that portion of the farm upon which the general crop is raised, should be prepared for the seed patch. The selected seed from the best plants is planted on this ground, and the crop is given good attention during the spring and early summer. First-class plants are again marked and labeled in the fall and the pickings saved. At times it may be necessary to reject the progeny of a selected plant, thus a larger number of individuals will offer greater opportunity for work the succeeding year. The seed from the individual plants can be planted in a single or separate rows; and the results for the season may be compared. Select one dozen plants in the seed plat from the various rows and determine the total yield made by each plant. Seed from the best plants can be used in planting the special plat the second season. Extra seed from the special plat the first year can be used for planting a larger area, which is known as a multiplying plat, while seed from the multiplying plat the second year can be saved and used on the commercial field the third year. The same definite plan may be carried out on the special plat each year, and an increase of seed for the improved strain can be obtained through the multiplying plat.

The average cotton grower may not care to carry out such a detailed line of work, in fact he may not have the spare hours to devote to a careful study of such a method, and yet he desires to bring about improvement in the variety which is grown upon his farm. A simple method can be suggested for adoption under such circumstances. When the picking season arrives, two or three good hands can go over the field and mark the most promising plants that can be found. Select vigorous, productive plants. As soon as the second picking is ready, the marked plants should be visited and all the mature cotton removed. This cotton is placed in special sacks for planting, and the seed obtained therefrom is used for planting the coming year. A few hours spent in marking and picking the cotton from the best plants in the field will in the course of a few years result in a decided improvement in the yields which are obtained. Every cotton grower should make this work a part of his business.—(Okla. E. S. B. 77.)

Just as it is true that blood and breeding tell in man and animals, so it is equally true that blood and breeding tell in the plant kingdom. The laws of heredity apply as strongly to the cotton plant as to any other creation.

This being true, better seed means better cotton. Better cotton means several things: It means stronger cotton plants. It means, other things being equal, earlier maturing cotton. It means more cotton per acre. It means a better grade of cotton. It means stronger, longer, and better fiber. It means more returns for money and labor expended. It means more respect for the grower, and finally it means a better farmer.—(Ark. E. S. B. 8.)

Relative Values of Varieties.—In deciding upon the relative values of different varieties of cotton the planter will be guided wholly by the number of dollars per acre which each variety will bring, and what variety he shall choose is a question to which no definite reply can be given. The same variety will give different yields in different years, on account of early or late frosts and the amount of rainfall in different months, especially from August to October. Some varieties are more liable to suffer from insects than are others. Some varieties which make a long, fine, and silky staple when grown on rich, damp, and alluvial soil, such as is found only along the larger rivers, are of but little value when planted on the high and dry uplands. Some varieties respond much more quickly than others to applications of fertilizers; some produce a moderate crop under almost any conditions, while others give an enormous yield when all the surroundings are favorable, but fail miserably when planted on unfavorable soils or with unfavorable climatic conditions. The relative prices of the lint from different varieties vary greatly from one year to another. The yield in pounds per acre for the short-staple varieties is always larger than for the long-staple sorts, though the amount of this difference will vary greatly with the localities where the crops are grown. In the hill regions the yield of the short-staple varieties is always much the greater, and is often fully double that of the long staples, and even on the lowlands of the southern portion of the cotton belt, the region best suited to the growth of the long staples, there is always a difference of yield in favor of the short staples. The long-staple varieties need not only a rich soil, but the best of care in cultivation, handling, and ginning, and require the highest intelligence and skill for their proper management.

Although some of the short-staple varieties are late in maturing their crop, still there are varieties which do mature much earlier than any of the long-staple varieties. In the southern portions of the cotton-growing region, where the season is long, this is a matter of little moment, but it becomes a point of the greatest importance in more northern latitudes, where the season without frost is not sufficiently long to mature any but the earliest ripening sorts. No variety of cotton will be profitable to the planter if it does not have a sufficiently long growing season in which to mature its entire crop, and it is safe to conclude that the short-staple varieties will usually be found the more profitable in that part of the cotton region north of latitude 32°.

The character of every plant is fixed in the seed from which it comes, and the peculiar vital force in each seed is determined to a great degree by the conditions surrounding the parent plant. Heredity plays an important part, but is not so strong as to wholly overcome the modifying influences of climate, soil, and season when these are acting in the same direction through generations. The law of the survival of the fittest applies to cotton as elsewhere, and when assisted by intelligence will soon develop in each region the special type of plant best suited to that particular locality.

Individual plants of any variety differ from each other so widely that it is an easy matter to select certain ones which have characteristics making them more desirable than are the majority of those in the same field. An ideal plant should be vigorous in its growth and wholly free from disease. The branches should be sufficiently strong and rigid, so that when they are loaded with green bolls they will not touch the ground. There is a great diversity of opinion as to the relative productiveness of the "cluster" and the "limbed" varieties, both styles of growth having their warm supporters. Many planters claim that the cluster or short-limbed varieties are best on deep and rich soil, while the longer-limbed sorts are superior for lighter soils. The results which have been secured in a large number of comparative tests, however, do not seem to show any foundation for this opinion, and indicate that the differences, if any, are attributable to other reasons than the mere length of the limbs. The short-limbed and cluster sorts can be planted more closely than can those varieties having longer and more spreading branches, but usually have smaller bolls, and none of the cluster varieties produces a long staple. Many of the cluster varieties have sharp points to the bolls, which make them unpleasant to pick, though this objection does not apply to all. Most of the cluster varieties mature early, though none of them mature as early as do some of the medium and short-limbed sorts, and a few mature quite late. The general results of the tests made show the cluster varieties to be better adapted for cultivation in the middle and southern cotton region than in the extreme northern belt. The bolls should be of good size, and a cross section should show a circle and not a triangle with rounded corners. When mature they should point downward rather than upward, so that rain and heavy dews will not enter and rot the contents; and they should also open widely enough to permit easy picking, but not enough to allow the seed cotton to drop to the ground. It is of no advantage to have more than three or four divisions or "locks" in a boll, as when spherical in shape, and with a given diameter, its contents can be no greater in six sections than in three. The bracts at the base of the boll should be small, so that they will not be in the way and become entangled with the seed cotton in picking. The lint should be pure white in color, strong, even, silky, uniform in length and twist, and should be easily separated from the seed in ginning. The staple should be not less than 25 mm. in length, and if 30 mm. can be secured it will be still better, though it will not be advisable to sacrifice a larger yield for a longer staple so long as the present relative prices of the long and short staples are maintained.

With early maturity and a medium length of staple secured, the only additional feature which need be considered is how to secure the greatest possible yield of lint per acre. It is often claimed that the larger the percentage of lint to seed cotton the more valuable the variety. This belief has no foundation in fact, and is really the reverse of true, provided the total yield of lint per acre remains the same. A crop of 500 pounds of lint and 1,100 pounds of seed per acre is certainly more valuable than the same crop of lint with only 900 pounds of seed. At present prices the seed is an important part of the crop, and if the yield can be increased without detriment to the total yield of lint it will add just that much to the value of the entire crop.

It may be said by way of caution that there is no necessary relation between the yield of lint per 100 pounds of seed cotton and the actual yield of lint per acre. A variety may yield a high percentage of lint, calculated on a given weight of seed cotton, and yet yield less lint per acre than another variety. It is probably more a question of seed than of lint. As the seed contains nearly all of the valuable elements taken from the soil, it is but reasonable to expect that a large yield of seed per acre will be attended by a correspondingly large yield of lint. We have but little doubt that some varieties that are popular with the mass of farmers because of their percentage of lint compared to seed simply produce less seed per acre instead of more lint per acre. It remains true, however, that a small-seeded variety—small in size and small in percentage of the whole—is better for poor land and low culture than a variety having a naturally large seed and a small percentage of lint.

It is a well-established fact that large seeds will produce stronger and more vigorous plants than small seeds of the same variety. Cotton is no exception to the rule, and if bred to produce small seeds it will be at the expense of the size, vigor, and health of the plant. A heavy yield of good lint is the main object to be attained, but this will not necessarily follow from a decrease in the size of the seed. Of course, the planter cannot afford to increase the percentage of seed at the expense of the lint, but if the pounds of lint per acre can be maintained the greater the amount of seed the greater will be the profit. Whether or not the weight of seed can safely be increased without a decrease in the yield of lint is a matter which has received almost no attention, but which is a promising field for the investigator.

GROUPS OF VARIETIES.

The short staple or upland varieties of cotton may conveniently be divided into seven classes, and to these may be added the long staple upland varieties as an eighth. Each of these general classes is given a name, and when practicable, an idea of the manner of growth of the plant. With each class name is associated the name of some distinct and well known variety as a type or standard. These groups are designated as—(1) Cluster varieties, or Dickson type; (2) Semi-cluster varieties, or Peerless type; (3) Rio Grande varieties, or Peterkin type; (4) The King-like varieties, or King type; (5) Big Boll varieties or Truitt type; (6) Long Limb varieties, or Petit Gulf type; (7) Intermediate varieties, or various types; (8) Long Staple Upland varieties, or Allen type.

The lines of demarkation between these groups are not always clear and distinct; one group often merges into another by almost imperceptible gradations, just as is the case with related varieties. Below is given a list of the varieties which are included under these several groupings, and also a general description of the varieties composing each class. Some varieties are not classified, either because of insufficient data, or more frequently because badly mixed. In cases of a medium degree of impurity, or variation, description has been made of predominant type.

Cluster Varieties, or Dickson Type.—The most striking characters are (1) the extreme shortness of the fruit limbs, and (2) the tendency of the bolls to grow in clusters, often two and even three from the same node. The plants are often tall and always slender and normally erect, though often bent down by the weight of bolls growing near the upper end of the main stem. The few base limbs are often long, or there may be no wood limbs, especially when these varieties are closely crowded or grown on poor land. The bolls and seed are usually small, but may be of medium size;—the seed are thickly covered with fuzz, which is usually whitish, with little or no brownish or greenish tinge.

As to the time of maturity these varieties must be classed as early, even though they sometimes make a second growth of bolls in the top of the plant which may fail to mature. In earliness they are surpassed by the varieties of the King type (Class IV). In percentage of lint they are variable, some of them equalling in this respect the Rio Grande group. Dickson, Jackson, (also called Limbless or African), U. S. Dept. Agr. No. 128, and Welborn, belong to this group.

Semi-Cluster Varieties, or Peerless Type.—These varieties have in less marked degree some of the qualities which distinguish Class I, being erect and having bolls borne singly very near together. Along the main stem are short fruit limbs increasing in length towards the bottom of the stem. The two to five base or wood limbs are usually of medium length. In size of bolls and size of seed and percentage of lint there is considerable diversity among these varieties. The seed are usually well covered with fuzz of many shades, whitish, greenish, or brownish. Most of these varieties are early or medium, but some that belong in both the semi-cluster and big boll groups are late in maturing. The following varieties are included in the semi-cluster group: Barnett, Berryhill, Blue Ribbon (L. S.), Cummings, Defiance, Dongola (B. B.), Featherstone, Garrard, Haralson, (B. B.), Hardin, Hawkins, Herndon, Hilliard, Lealand, McCall, Minor, Montclare (B. B.), Norris, Peerless, Pullnot, Rogers (B. B.), Sterling, Tyler, and Woodfin.

Rio Grande Varieties, or Peterkin Type.—The characters which most distinctly mark this class are: (1) The large proportion of lint, usually 35 per cent. or more of the weight of seed cotton, and (2) Seeds of which many are bare of fuzz, except at the tip end, or so scantily covered with fuzz that the dark seed coat shows through. The plants are well branched, and usually, on upland soil, of medium size. On many plants the stems and branches are of a deep red color. The bolls are small to medium and the seed are quite small. In time of maturing these varieties are usually neither very early nor extremely late.

The varieties included in this group are conveniently divided into two sub-groups according to the presence or absence of naked, smooth seed. The following Rio Grande varieties have a considerable proportion of naked seed: Anson Cream, Bates, Braddy, Brannon, Cameron, Carolina Queen, Champion, Combination, Crossland, Dixie Wilt-Resistant, Gayosa (?), Mattis (?), Moss, Parker, Peterkin, Pinkerton, Ptomey, Shine Black Seed, Sistrunk, Texas Oak, Texas Wood, Victor, and Wise.

Rio Grande varieties having practically no naked seed, but having many seed so scantily clothed with fuzz that the dark seed coat shows through, giving a brown color, are the following: Berryhill, Borden, Dearing, (probably) Eureka, Excelsior(?), Favorite, (probably) Gregg, Layton, Park's Own, Speight, and (probably) Toole.

King-like Varieties, or King Type.—The varieties of this group are the earliest of American cottons. The plants are usually small but may be of medium size. The limbs are numerous and the fruit limbs are rather long in proportion to the height of plant. The fruit limbs are often crooked at the joints, reminding one of the crooked twigs of a black jack oak (*Quercus marylandica*). The base limbs are short and sometimes replaced by fruit limbs bearing a number of bolls on each. King is essentially a short jointed, compact plant with an abundance of slender, rather crooked limbs. The bolls of this group are small; the seed are usually small and thickly covered with fuzz which is usually brownish, with an occasional seed showing a greenish tint. The percentage of lint is usually 33 to 35, and sometimes higher. King and its synonyms have on many blooms a red spot near the base of the inner portion of each petal. The varieties of this group are: Dozier, Grier, Golddust, Hodge, King, Lowry, Mascot, Missionary, and probably Shine Early.

Big Boll Varieties or Truitt Types.—The character which especially distinguishes this class is the large size of bolls, of which only 45 to 68 are required to yield a pound of seed cotton. Other specially notable qualities are late maturity and vigorous growth of stalk. The seed are large or very large, and covered with a thick fuzz, generally brownish white or whitish, a part of the seed of many of these varieties being covered with a deep green fuzz. The per cent of lint often runs rather low and is usually between 31 and 34. The bolls are not closely clustered; in some varieties the upper limbs are so short as to give the top of the plant the erect, slender appearance which is common among semi-cluster varieties. In typical plants the base limbs are of short or medium length, the number of fruit limbs and bolls relatively few, and the main stem is rather short. However, a number of varieties are included here that have all or many of their plants of the semi-cluster form.

The following varieties belong in this group: Alex. Allen, Anderson, Bancroft, Banks, Berry, Bohemian, Brown No. 1 (?), Cheise, Christopher, Cleveland, Cliett, Cook Improved (?), Coppedge, Culpepper, Diamond, Double Header, Dongola, Drake (Ala.), Duncan, Ellis, Grayson, Gunn, Haralson, Hunnicutt Big Boll, Hutchinson, Jones, Langford, Lee, Maddox, Montclare, Mortgage, Lifter, Ozier Big Boll, Reliable, Rogers, Rowden, Ruralist, Russell, Scogin, Sewell, Schley, Smith Improved, Smith Standard, Southern Wonder, Spearman, Strickland, Tatum, Texas Bur, Texas Storm Proof, Thrash, Todd, Triumph, Truitt, Webber-Russell, Whitten, and Wyche.

Long Limb Upland Varieties, or Petit Gulf Type.—The varieties in this case grow to large size and have long limbs and long joints, the plants presenting a straggling appearance or want of compactness. The bolls and seed are both of medium to large size, the latter covered with fuzz of various shades. The percent of lint is usually low. The long limb form is usually accompanied by unproductiveness on average upland soil. The following varieties are included in this group: Hagaman, Louisiana, Peeler, Petit Gulf, and probably Red Leaf.

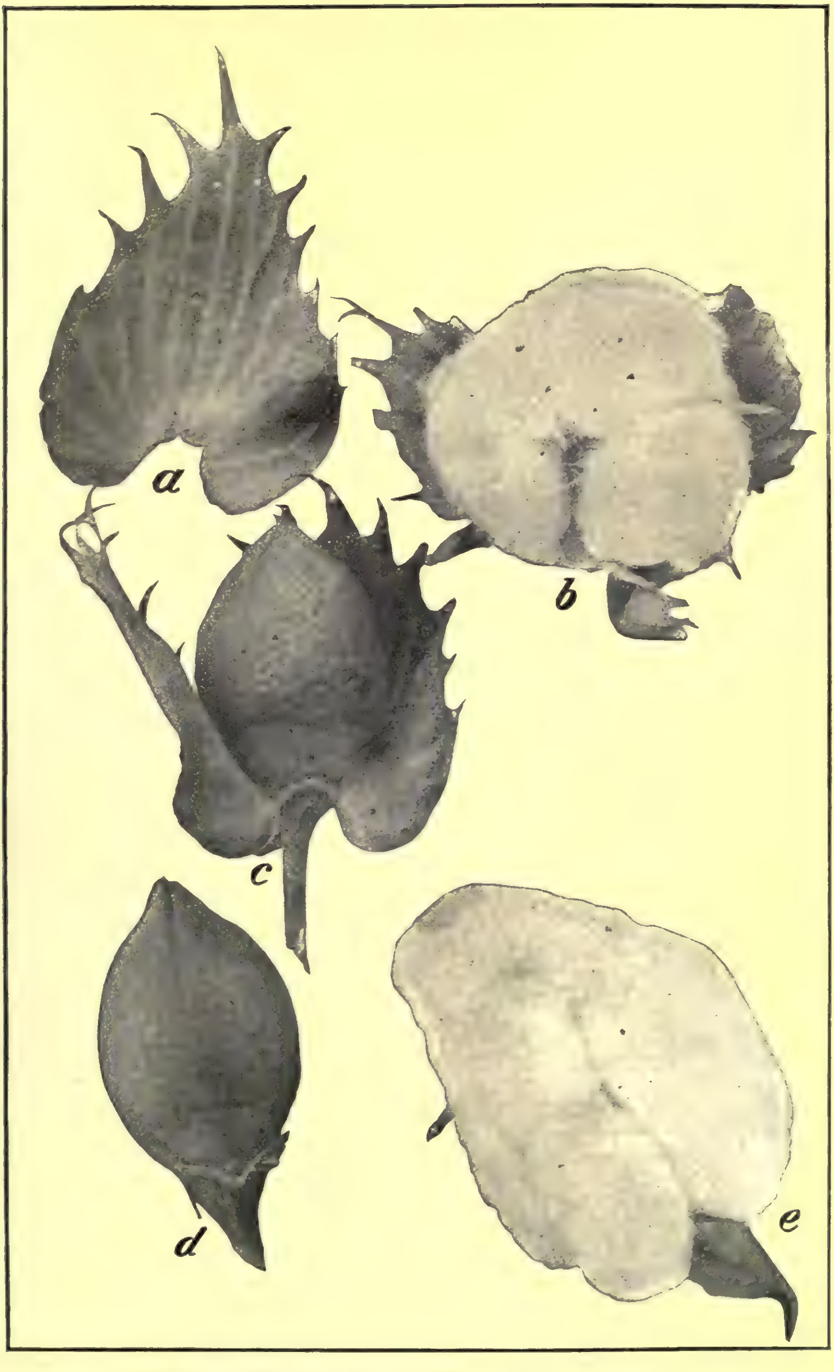
Intermediate Varieties, or Various Types.—This group is added to the scheme of classification, primarily to include varieties having limbs a little too long to bring them within the semi-cluster class. It is also made to include a few other varieties that are intermediate between any two of the other seven groups. To this division are assigned, Breeden, Boyd, Edgeworth, Eureka, Excelsior, Gold Standard, Hunnicutt (J. B.), Lewis, Meredith, Roby, Rosser, (probably) Shine Early, Sprueill, (possibly) Toole, Tucker, and Webber-Russell.

Long Staple Varieties, or Allen Type.—The length of staple is the distinguishing characteristic. The lint usually measures 1¼ to 1½ inches in length, or 28 to 34 millimeters or more. An almost invariable accompaniment to great length of staple is a low proportion of lint. The plants grow to large size, have limbs of great length, and usually present a straggling appearance, though in some varieties only the base limbs are long, the upper limbs bearing a number of bolls close to the main stem, and giving the upper portion of the plant the appearance of great prolificacy. . The bolls are not very large, but are long, usually slender, tapering to a sharp point. Most of these long staple varieties are late in maturing a crop. The seed are mostly of medium to large size, usually densely covered with fuzz, from which all trace of green is absent, the color being almost pure white, or in some varieties of a brownish tint. In some varieties the seed are bare. In this group are included: Allen Long Staple, Allen Hybrid Long Staple, Black Rattler, Blue Ribbon, Cobweb, Cook Long Staple, Colthorp, Davis, Doughty (?), Eclipse (?), Ferguson (?), Florodora, Gholson, Griffin, Keno, Laclede, Matthews (?), Moon (?), New Century (?), Ozier Long Staple, Simms, Southern Hope (?), Sunflower, and Wonderful. The varieties followed by an interrogation point are on the dividing line as grown on dry sandy upland soil. On moister soil they usually have fiber long enough to admit them into the long staple group, or into a subdivision of that class which may be called the medium staple group.

Productiveness of Varieties.—Tests of the yields of lint per acre have been made for 90 varieties, in addition to a much larger number grown on areas too small to indicate the yield.

Among the varieties tested for a considerable number of years the following are frequently near the top of the list: Peerless, Peterkin, Russell, and Truitt.

Among the varieties that have been tested only a few years, the following have usually taken high rank in yield of lint: Cleveland Cook Improved, Jackson, Layton, Pullnot and Toole.—(Ala. E. S. B. 140 and several other authorities.)



Open and Unopened Cotton Bolls. Yuma, Ariz., 1907.

HOW TO BECOME ACQUAINTED WITH A VARIETY.

Many farmers who have become quite skillful in detecting differences in the lint and seed characters of cotton pay very little attention to the plants themselves. They are in the condition of the general public that recognizes differences between fruits of different varieties of apples, but lacks the skill of the apple grower who sees even more differences between the various kinds of trees than between the apples they produce. Doubtless there are many people who can not learn to appreciate such differences, but most of those who are willing to use a little time in training their eyes are surprised to find that they can readily distinguish differences that they have previously overlooked entirely. The different kinds of cotton plants will cease to look all alike and stand out as distinctly as different breeds of poultry or other domestic animals. The differences of color that often help to distinguish breeds of chickens are lacking, of course, in the cotton, but it would not require a very skillful fancier to tell a white cochin from a white leghorn or a white plymouth rock.

The technical terms and elaborate measurements that are often used in the scientific study of variations are calculated to give the idea that it is a difficult matter to recognize the variations of plants in the field. In reality it is not so difficult as to recognize differences between individuals of the same variety of sheep or poultry, and this most farmers do. The making of scientific descriptions and measurements of variations is an entirely different problem from that of recognizing them in the field.

It is customary for breeders and seed growers to publish descriptions and pictures of their varieties, but the farmer should not expect to gain an adequate acquaintance with a variety from such sources. It is hardly possible to describe the differences between closely related varieties of such a plant as cotton so that they can be seen at once without skill and practice in observation. Indeed, many skillful breeders do not themselves know what the differences are that they use in selection, and are inclined to imagine themselves possessed of some special sense instead of a refinement of ordinary eyesight.

Even a photograph of a plant is of relatively little value as a guide or standard in the selection of cotton, for the plants of the same variety differ greatly in different places and different seasons. The familiarity that is needed for purposes of making selections has to be gained in the field where the selection is to be carried on. Selection is a matter of skill as well as of knowledge. The farmer must be willing to give himself a little training in the field and not expect to become fully qualified by anything he can read in a book.

The more familiar with a variety one becomes the more evident it will be that every field is likely to be different and may require to be judged by a different standard. The training of the eye so that it can carry the necessary standard is the secret of the art of selection. It is this that determines the farmer's ability to select his own cotton to the best advantage.

If the farmer doubts his own ability to acquire the necessary skill or is unwilling to take time to train himself, he may find that the wife or the children can give him valuable assistance. Women are often more expert than men in the matching of colors and qualities of fabrics, and children often have more acute powers of perception. European growers of seeds of high-grade varieties of flowers and vegetables claim that women and children are more skillful than men in cases that require extremely fine discrimination. If the necessary talents of good eyesight and keen discrimination should prove to be rare, there would be the greater reason for calling attention to the need of having them utilized by their fortunate possessors. —(B. P. I. B. 66.)

RAISING SELECTED SEED FOR SALE.

Farmers who acquire the necessary skill in selection and are consequently able to raise a uniform crop will often secure an additional advantage by selling seed to their neighbors. Many intelligent farmers who wish to obtain an improved variety of cotton will prefer to buy seed enough to plant a large field or to stock the whole farm at once and thus save themselves the extra trouble and loss of time required in beginning with a peck or a bushel. The same pains, or even greater, have to be taken to keep a small quantity of cotton from becoming mixed, either in the fields or at the gin, than for a large quantity. To bring a large quantity of a new and untried variety from a distance might be quite unwise and is a very different matter from adopting a variety that is behaving in a uniform manner in the same locality.

Local communities will profit in several ways by the presence of careful growers of selected seed. The seed that has been raised and selected in the same community is likely to give better results than any stock of the same variety that could be brought in from distant localities. Farmers who expect to sell their seed in their own community are likely to be much more careful to maintain the uniformity of the stock than those who expect to ship their seed to nonresident seed dealers.

A variety that can be obtained in quantity from a local grower is also more likely to be adopted by a whole community, which is another distinct advantage. The product of the community as a whole becomes more uniform and secures a better standing in the market. With one variety grown and carefully selected by a whole community, the difficulties of protecting the cotton from admixture at the gin or from cross-fertilization by bees in the field are greatly diminished.

The farmer who has learned how to maintain uniformity in his seed plat effectively, has only to extend his method over his whole farm if he wishes to produce high-grade seed. No matter how uniform the variety may have been in the seed plat or in the fields in the preceding year, attention should still be given to the removal of any degenerate plants that appear. A new or unfavorable piece of ground or a bad season may bring out an unusually large number of degenerate individuals, and if these are allowed to remain in the field and cross-fertilize with the good plants the whole stock may be seriously injured. A single season's neglect may destroy the benefits of many years of careful work.—(B. P. I. B. 66.)

EGYPTIAN COTTON CULTURE IN THE UNITED STATES.

The Egyptian varieties are apparently best adapted to culture under irrigation in regions where there is practically no rainfall during the growing season. The only part of the United States where these conditions exist and where at the same time the summers are long and hot enough for profitable cotton culture is the extreme Southwest, from western Texas to southern California.

Since this type of cotton will continue to produce bolls and ripen fiber until a hard frost occurs, it is obvious that the largest yields can be obtained in regions where the autumn temperatures are highest. It must therefore be concluded that the greatest success with Egyptian cotton is to be expected in southern Arizona and southeastern California—a conclusion that is supported by the experience so far gained. The valleys of the Salt River and of the Colorado River (Yuma Valley) in Arizona and the Imperial Valley in California have been found to be admirably adapted to the production of this type of cotton.

The variety of Egyptian cotton that is most used by American manufacturers is Mit Afifi. The grade most largely used averages 1⅜ inches in length and furnishes numbers of yarns up to 70's and 80's. Jannovitch, and to a small extent Abbasi, averaging 1½ to 1⅝ inches in length of fiber, are used as a substitute for the lower grades of Sea Island in manufacturing fine yarns (100's and upward). A small quantity of the inferior Ashmuni variety is imported.

There are four principal reasons for the extensive use of Egyptian cottons in the United States: (1) They are best adapted to mercerizing and other processes that give a high finish to the cloth and cause it to resemble silk; (2) their exceptional clearness (freedom from nep) and luster, as well as their capacity for taking dyes, fit them for mixing with silk and for filling sateen, India linens, and similar goods having a brilliant surface; (3) the brown color of Mit Afifi fiber allows it to be used without dyeing in manufacturing goods such as Balbriggan underwear and lace curtains in which the ecru shade is desired; (4) they can be used for the manufacture of sewing thread and other articles which need to be very strong and for which no other type of cotton but Sea Island is suitable. Owing to the higher price of the latter, Egyptian cottons can in many cases be advantageously substituted.—(B. P. I. B. 128.)

HANDLING THE CROP.

After devoting his best energies for a whole season to the production of a fine crop of cotton, the farmer must still continue his vigilant oversight until the staple has left his hands. There are many ways in which it may be injured and its value reduced. All defects in the cotton are ultimately charged to the farmer's account and reduce the price paid to him. By a little care much of the waste can be avoided; hence strict attention should be paid to these factors.

GRADE: DEFINITION AND IMPORTANCE.

In the cotton market the term staple refers to the length and fineness of the fiber, and these points are influenced most by seed selection. The term grade, on the other hand, indicates the appearance of the cotton as regards cleanliness and color, qualities influenced mainly by the manner in which the cotton has been handled. The price is considerably influenced by the grade.

Loss of Bloom or Luster.—The best staple has a gloss or luster which adds greatly to its beauty and is indispensable for certain kinds of fabrics. This bloom is destroyed by exposure to sun and storm when cotton is left long unpicked, and the staple then has a gray, lifeless appearance, sometimes termed mildewed or weather-beaten. A similar effect is produced by picking cotton when wet with rain or dew and storing it in piles without first drying it in the sun. To preserve the staple at its best, pick often—once a week, if possible—and expose the seed cotton to the sun to dry. This is done by spreading it in a shallow layer on a low roof or arbor, where it is turned frequently until so dry that the seed will crack between the teeth.

Loss of Strength.—The loss of luster is accompanied by a lessened strength, so that a staple originally good fails to make as strong thread as before—an added reason for better care. Very dry cotton is also not as strong as that which, under proper treatment, has retained its natural moisture.

Nep.—Spinners designate as nep small white specks in the baled cotton, which they find very difficult to remove in spinning and which often go into the thread and appear in the completed fabric as white dots. These neps are in reality tangles in the fibers, which when viewed under a microscope are seen to be weak and undeveloped. They are due in part to picking cotton before maturity; a boll that is forced open to extract the lint is a source of nep, as the cotton in it does not get the necessary exposure to the sun to dry and straighten and strengthen the fiber. Other nep originates with weak cotton from diseased bolls or from any other cause that prevents the fibers from attaining full development. Such undeveloped staple comes from the gin full of nep. Poor ginning, however, by weakening and breaking fibers increases loss from this cause. Pickers should be cautioned against picking unripe bolls. Thorough sunning will in part remedy the trouble, and good culture, by producing healthy plants, will do more.

Broken Leaf, Etc.—The presence of fragments of leaf, weed seeds, and other foreign matter in the cotton reduces its grade. These are often difficult to avoid, particularly after storms, when bits of the dried square, or involucre, are often mingled with the cotton; but pickers should be watched and cautioned against picking dirty cotton. Fortunately, the spinners find it easier to remove this class of impurities than the nep previously mentioned.

Short Fibers.—A large part of the waste is due to short fibers, which have to be combed out. They originate in part in variations in the length of the staple on the seed, a serious fault, to be remedied by proper seed selection. Short fibers are in other cases due to imperfect ginning, which breaks or crimps the staple and may be avoided by better management.

Weak Fibers.—The greater part of the waste is due to the presence in the baled cotton of staple from undeveloped or diseased bolls. The bolls in such cases do not open and the fibers do not expand but remain matted together in a "hard lock." All locks that do not open out after drying may be assumed to be worthless on account of weak and undeveloped staple. Pickers should be instructed not to gather hard locks, and in the assorting after picking all remaining ones should be thrown out. Seed cotton still containing hard locks when it reaches the gin can be improved by setting the stripper bars well back from the roller to allow the locks to fall through. Close ginning is a mistake, for it costs the farmer more through deterioration of his cotton than he gains by the slight increase in weight.

The number of hard locks can be greatly reduced by bringing the cotton to perfect maturity through attention to fertilization and culture and to the control of diseases.

Lack of Uniformity in the Bale.—Separate late from early pickings. Buyers desire to have each bale uniform within itself. If, therefore, a late picking is inferior to an earlier one, it should not be ginned and packed with it, as the price of a bale is determined by the poorest cotton found in it after thorough sampling.

Yellow Cotton.—Buyers invariably complain when a sample of cotton contains yellow staple, and the grade and price are consequently reduced. Yellow tufts in the ginned cotton come from discolored locks that should have been left unpicked or been sorted out before ginning. They originate, as a rule, in bolls attacked by the anthracnose or bacterial boll-rot. Their presence in a bale is an indication of too close ginning.

Sand.—A bale of cotton always contains considerable sand which has been blown into the open bolls. This is quite unavoidable, but when cotton has been left unpicked and has blown out on the ground the quantity of dirt is increased.

Moisture.—An element of waste from the spinner's standpoint is the moisture which evaporates during the process of manufacture. This moisture may be excessive in cotton picked early in the season and ginned without drying. There may, on the other hand, be a lack of moisture. The cotton may be overdry and appear harsh and brittle. Such cotton gives trouble in spinning, because of the electric current it develops.

The question of moisture is one of the most important connected with the handling of cotton. Either an excess of moisture or a lack of it reduces the grade. The farmer, however, must never add water to the cotton, but he should seek to retain the optimum amount of natural moisture. This means that to drive off excessive moisture freshly picked cotton should be sunned until the seeds will crack in the teeth. The staple will then be slightly overdry and unfit to gin or offer to the buyer. To restore its grade it should be "bulked." Bulking is placing the seed cotton, after sunning, in a large, deep, square pile in a cool room. It should be packed down solidly and, if the air is dry, covered with blankets or boards and left from three to six weeks before ginning. When it comes out of bulk the staple has lost its harsh feeling and is soft, oily, and glossy.

Care must be taken never to bulk cotton that has not previously been well dried, or the pile will heat. On the other hand, a loose, conical pile, formed by throwing seed cotton into a storeroom, is not a bulk, for it does not prevent the cotton from drying out still more. As a rule, cotton brought to the gins early in the season is too green and damp and needs sunning to put it into good condition, while that coming in late or taken from the storehouses during the winter is overdry and consequently harsh and brittle. Both the lint cotton and the thread spun from it lack their full strength if too dry. Everyone knows how a dry twig will snap in the fingers, while a green one only bends. The same to a less degree is true of the cotton fiber. The quality is best maintained, however, by avoiding overdrying rather than by the addition of moisture.

Injury in Ginning.—The grade of cotton is often reduced during the process of ginning. This may be the fault of the farmer, as when he brings his cotton to the gin damp or full of hard or yellow locks or broken leaf and insists on close ginning; or the fault may lie with the ginner, who has failed to adjust his machine so that no seed can be broken. Briefly stated, seed cotton must be dry; if green or wet, "crimping" invariably results, to the serious injury of the fiber. The seed cotton should be free from hard locks or else the stripper bar should be adjusted to let them fall through with the seed. Close ginning is a form of adulteration instantly detected by the buyer and very costly to the farmer. The modern fruit grower has learned that he can not profitably mix his culls with his firstgrade fruit, and the cotton grower must come to a similar conclusion.

The most frequent defects due to ginning are the presence of portions of broken seed and the cutting or crimping of the fiber. Since poor ginning costs the farmer, at a conservative estimate, 1 cent a pound, the ginner should be required to maintain his gin in perfect adjustment and to gin the cotton free from cracked, clipped, mashed, or whole seed and free from crimp.

The ginned cotton should come from the roller steadily and in an unbroken flake. Whenever it does not do this, an examination will show that the adjustment is not perfect, and the cotton is liable to sustain injury unless the trouble is corrected.—(F. B. 302.)

COTTON SEED AND ITS PRODUCTS.

The lint was formerly considered the only valuable product of cotton, but modern enterprise has found a use for almost every part of the plant. In fact, of all the staple crops of the United States not one can be produced with a slighter drain upon the elements of fertility of the soil than cotton, and none excels it in variety and value of its products.

The lint is comparatively poor in fertilizing constituents, containing only 0.34 per cent of nitrogen, 0.10 per cent of phosphoric acid, and 0.46 per cent of potash. It is evident, therefore, that if the lint were the only part of the plant removed from the soil on which it was grown cotton would be one of the least exhaustive of farm crops. The only other product of the cotton plant whose fertilizing constituents need be permanently lost to the soil is the oil, which also contains comparatively insignificant amounts of these constituents. It can be shown that, even when the seed is taken away along with the lint, cotton still removes smaller amounts of fertilizing materials from the soil than either oats or corn.

If the stubble is turned under (not burned) and the seed or its equivalent in meal is returned to the soil, the growing of cotton exhausts the soil fertility very slowly. In fact, the direct loss to the soil under these circumstances is not more than one-half pound of phosphoric acid, 1¾ pounds of potash, and 1¼ pounds of nitrogen per acre in a crop of 300 pounds of lint per acre. The stalks and other refuse on an acre after the seed cotton has been picked amounts to about 850 pounds in weight with average yields of lint. Stock is usually turned in to pasture on this stubble after the last picking. The animals strip off the limbs and pods, leaving finally nothing but the hard and brittle bare stalks.

Air-dry cotton plants, with seed cotton removed, rank as a feeding stuff with the coarse, dry fodders, such as cornshucks, corn stover, and rye, oat, and wheat straw. One hundred pounds of air dry material contains on the average: Water, 10.01 pounds; ash, 6.13 pounds; protein, 6.35 pounds; fiber, 34.38 pounds; nitrogen-free extract, 41.15 pounds, and fat, 1.98 pounds.

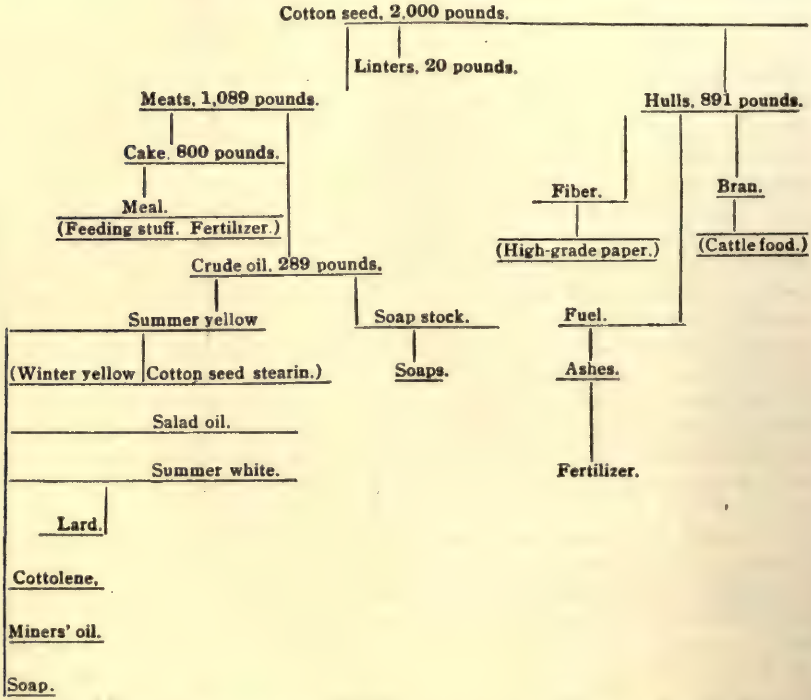
It has been proposed to utilize the cotton stem for the preparation of fiber for cotton bagging, etc., and a process has been patented for this purpose, but the enterprise has not proved successful, owing largely, if not entirely, to the difficulty of devising a machine that will satisfactorily work up the rough, irregular material. It is claimed that under favorable conditions 5 tons of stalks will yield 1 ton of bark, producing about 1,500 pounds of fiber. Bagging made from this fiber is pronounced by dealers to be of first-class quality. The stalks are also highly valued for fuel in countries such as Egypt, where other supplies are scarce, and the bark of the roots (*Gossypii radicis cortex* U. S. P.) contains a principle which has long been used for medicinal purposes, its action being similar to that of ergot.

The uses of these by-products have now reached large proportions and are constantly being extended. It is entirely possible that ultimately cotton will be grown as much for the seed as for the fiber. Accurate information regarding the value and uses of cotton seed and its products is therefore of great importance not only to the consumer but also to the producer.

Cotton Seed.—For many years cotton seed was considered only useful to plant. Thousands of tons of this seed were annually burned or dumped into the rivers. But at last it was shown that cotton seed was not only valuable as a fertilizer and feeding stuff in its crude state, but was capable of furnishing products that are among the most important elements in our national industries. The oil is the main product, and is used for a great variety of purposes. The residue after the removal of the oil is a valuable fertilizer and feeding stuff, the hulls excellent fuel, the ashes of the hulls a fertilizer rich in potash and phosphoric acid, and the refuse from the oil refining valuable stock for the manufacture of soaps. The seeds also contain a coloring matter which has been used to some extent as a dyestuff. Thus a vast mass of material which was once looked upon as necessarily a waste product has become of very great commercial value.

The following diagram, prepared by Grimshaw on the basis of the actual results at oil mills, shows how a ton of cotton seed is utilized:

Products from a Ton of Cotton Seed.



The above diagram was prepared several years ago. Recently the processes of manufacture have been so improved that over 300 pounds (40 to 45 gallons) of oil can be obtained from each ton of seed, and delinting machines have been introduced which remove a much larger amount of linters than is given in this diagram, the proportion of hulls being correspondingly reduced.

The process through which the seeds are put at the oil mills is thus concisely described: The first process in preparing the dry seed for the mill is to free it from dust. The cleaned seeds are then transferred to the sheller, which consists of a revolving cylinder containing cylindrical knives and back knives. The sheller revolves at great speed, and as the seed is forced between the knives the pericarp or hull is broken and forced from the kernel. The mixed shells and kernels are separated in a winnowing machine by a strong blast of air. Being thus cleaned, shelled, and separated, the kernels are carried by a system of elevators to the upper story, and then passed down into the crusher rolls to be ground to flour. After this crushing the meats drop into a conveyer, which delivers them to the heaters. Close to the heaters stands the "former," which shapes the meats into cakes for the press. The cakes as they come from the former are wrapped in haircloth and removed by hand to the press, where they are arranged in a series of boxes, one above the other, between the plates of the press, and subjected to a pressure of 3,000 to 4,000 pounds to the square inch by hydraulic power. The cakes, pressed as solid as boards, are taken from the press, stripped of the cloths, and stacked to dry. When dry they are passed through a cake cracker, which breaks them into fragments of a size suitable to be fed to a mill. The mill grinds these fragments into a fine meal, which is put up into sacks containing 100 pounds. Sometimes the meal is bolted to separate it from small pieces of the hull, which, being tough and leathery, are not readily ground up.

Cotton-Seed Oil.—As a food cotton-seed oil was first used as an adulterant to soften and temper lard intended for use in cold climates. Later on the fluidity of the oil itself was corrected by mixing it with beef fat. This mixture was put on the market under the name of compound or refined lard. It was so kindly received by the public that before long all disguise was dropped and it was sold on its merits in competition with lard.

The soap made from cotton-seed oil is claimed to be especially adapted to wool washing and is now largely used by the woolen mills in this country and also extensively in England and Scotland. The oil has also been found to be excellent for laundry, family, and fancy soaps.

Another by-product in the manufacture of cotton-seed oil is a wash powder made from the soap stock, which, however, owes its principal virtue to the soda or potash used in the refining processes.

Cotton-Seed Meal.—This is bright yellow in color when fresh, with a sweet, nutty flavor, but becomes discolored and deteriorates with age. The black specks seen in some samples show either an accidental impurity or an intentional adulteration with hulls. Its composition depends upon the composition of the seed and on the completeness with which the hulls and kernels are separated, and the oil expressed. Cotton-seed meal is poor in carbohydrates (starch, sugar, etc.), but rich in fat and protein (nitrogenous matter). In fact, it is so rich in the latter constituents that it can be utilized to advantage as a food for animals only when mixed with some coarse fodder rich in carbohydrates, thus furnishing a more evenly balanced ration.

In comparative valuations of feeding stuffs it has been found that cotton-seed meal exceeds corn meal by 62 per cent, wheat by 67 per cent, and raw cotton seed by 26 per cent. As regards digestibility, cotton-seed meal compares very favorably with other concentrated feeding stuffs, as the following statement of the amounts of digestible food ingredients in 100 pounds of meal will show: Protein, 37.01 pounds; carbohydrates, 16.52, and fat, 12.58.

Cotton-seed meal is extensively used as a fertilizer, and for this purpose it is worth from $20 to $25 per ton, determining the price on the same basis as that used in calculating the value of other commercial fertilizers. It frequently happens, even in Northern States, that cotton-seed meal can be bought for less than its fertilizing value, calculated on the above basis. Its composition with reference to fertilizing constituents is shown by the following summary of results of 204 analyses:

Fertilizing Materials in Cotton-Seed Meal.

	Water.	Ash.	Nitrogen.	Phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Minimum	4.34	3.35	3.23	1.26	0.87
Maximum	12.57	9.90	8.08	4.62	3.32
Average	7.81	6.95	6.79	2.88	1.77

Although cotton-seed meal contains considerable percentages of phosphoric acid and potash, a large proportion of which has been shown to be readily available to plants, it is chiefly used as a source of nitrogen in fertilizers. Cotton-seed meal has given excellent results, especially in the Southern States, as a fertilizer for sugar cane, cotton and corn. It has also been successfully substituted for barnyard manure in the culture of tobacco.

While cotton-seed meal, as the above facts show, has high value when applied directly as a fertilizer, a more rational practice in many cases is to feed the meal to animals and apply the resulting manure to the soil. From 80 to 90 per cent of the fertilizing materials of the meal will thus be recovered in the manure, and additional benefit will be secured in the production of meat, milk, etc.

Cotton-Seed Hulls.—They constitute about half the weight of the ginned seed. Analysis shows them to be principally crude fiber and nitrogen-free extract matter, these two constituents, with water, constituting more than 90 per cent of the hulls. The hulls are hard and dry, usually covered with a fuzzy lint. On superficial examination they appear to be a most unpromising food material, and, in fact, until a comparatively recent period they were universally considered worthless for this purpose. They have been found to be a cheap and effective substitute for hay.

Digestion experiments have indicated that 10 per cent of the protein of cotton hulls is digestible, 38 per cent of the fiber, 40 per cent of the nitrogen-free extract, and 77 per cent of the fat; so that 100 pounds of hulls contains the following amounts of digestible food constituents: Protein, 0.42 pounds; carbohydrates (including fiber and nitrogen-free extract), 30.95 pounds, and fat, 1.69 pounds.

Cotton-Hull Ashes.—Cotton-hull ashes have been on the market since 1880 and have come into great demand as a cheap potash supply, especially among tobacco growers. The quality of these ashes varies greatly on account of impurities introduced, principally by the use of other fuel with the hulls. The potash exists largely as carbonate, which is readily available to plants, but there is also a considerable percentage of silicate of potash, which is difficultly available. The value of cotton-hull ashes depends almost exclusively upon the amounts of potash and phosphoric acid they contain.—(F. B. 36.)

VALUE OF COTTON SEED TO THE FARMER.

The results of feeding tests with cotton seed, and cottonseed meal are worthy of careful study by the farmers. The facts, as demonstrated, are: (1) a pound of cotton seed has a greater value for feeding cattle than a pound of corn; (2) a pound of cotton-seed meal has a feeding value about equal to two pounds of corn; (3) that at least 85 per cent. of the fertilizing ingredients in the feeds is excreted by the animals fed, and may be recovered in the manure; (4) that nearly half of the fertilizing ingredients excreted is found in the urine; (5) that both cotton seed and cottonseed meal may constitute a very important part of the grain feed of cattle without injury to their health; (6) that cotton seed and cotton-seed meal, when fed to dairy cows in proper quantity and properly combined with other feeds, do not injure the quality of either milk or butter.

Value of a Ton of Cotton Seed.—With corn at 40 cents per bushel a ton of cotton seed is worth $16.70 as a feed, for either beef cattle or dairy cattle. At present prices for commercial fertilizers nitrogen costs about twelve cents per pound, and phosphoric acid and potash each five cents per pound. Allowing these prices for the same ingredients in manure, we have $9.09 as the fertilizing value of the manure, for each ton of seed fed, making for a farmer a total value per ton of $25.79. Farmers sell their seed for four to six dollars per ton! Some of them sell for two dollars per ton! !

Value of a Ton of Cotton-Seed Meal.—In a similar way we find the feeding value of a ton of cotton-seed meal to be $28.56, and the manure to be worth $19.13 for every ton of meal consumed, making a total value of $47.69 that a farmer might derive per ton by first feeding the meal to cattle and applying the manure to his land.—(Miss. E. S. B. 60.)

Additional References.—S. C. E. S. B. 120, 140; U. S. E. S. B. 9, 16, 19, 28, 34; F. B. 285, 314, 326, 364; Miss. E. S. B. 1, 60, 62, 88, 98, 113, 135, 143, 148, 151; Ga. E. S. B. 47, 52, 56, 70, 75, 79, 83; S. C. E. S. B. 2, 78; B. P. I. B. 88, 128, 155, 159, 163, 200, 210; B. P. I. Cir., 11, 18, 29, 66; Y. B. 1903, 1904; U. S. E. S. B. 42; Tenn. E. S. B. 5; La. E. S. B. 92; N. C. E. S. B. 71; Ala. E. S. B. 6, 25, 130, 138; Ariz. E. S. F-B. 70; Fla. E. S. B. 32.

FLAX FOR SEED AND FIBER.

In considering the cultivation of fibers in this country, with the exception of cotton, the flax crop should undoubtedly be given first place. In 1890, it was ascertained that flax was grown by the farmers almost wholly for seed, the straw, of inferior quality, going to the tow mills or the paper mills, when used at all, and selling for from $1 to $8 a ton, the average in the different sections being not more than $2.50 to $4. By far the larger quantity was wasted or burned, and represented no money value whatever. While in the older States the area under cultivation was found to be small and steadily decreasing, in the newer States, or States where agriculture is being pushed steadily westward from year to year, the area under cultivation seemed to be fairly holding its own, and was stated in round numbers at about 1,000,000 acres.

The incentive to grow flax for fiber as well as seed was never more urgent than at the present time. In several flax-growing countries the supply is steadily declining, and foreign buyers are already inquiring in this country regarding the possibility of making good a portion of this deficiency from the product of American farms.

The farmers of the United States use improved implements and machines in all farm operations, and American farm implements are recognized as the finest in the world. What invention has done for other rural industries is possible for the flax industry and by the use of improved machines in every stage of flax culture, the difference in wages between this country and the Old World will be more than equalized. The "American practice," then, means simply an intelligent practice, for the growth of both fiber and seed, achieving economical production by the employment of labor-saving machinery, even in the pulling of the flax straw.

Fine flax can be grown in the United States, providing the farmers grow it intelligently and perseveringly—not one year, or two, or three, but year after year, growing each year a little, and growing it well.—(F. B. 27.)

Varieties of Field Flax.—Considerable attention has been given to the question of the existence of fixed varieties within the species known as *Linum usitatissimum,* the common field flax. Most practical growers throughout Europe, and especially in Russia, contend that there are no absolutely fixed varieties. Numerous observations made in the different countries, however, concerning single forms, show that there are several well-marked varieties of cultivated field flax. Among these are at least two which should be classed as species, namely *Linum usitatissimum* L., including all of the small-seeded varieties, and *Linum humile* Mill., including the large-seeded varieties. Of the first-named species, the following varieties may be listed: (1) Common blue-flowered fiber flax; (2) common blue-flowered seed flax; (3) dehiscent-boll seed flax; (4) common white-flowered fiber flax; and (5) white-flowered white-seeded flax.

Of the big-seeded Sicilian species, *Linum humile,* the following types may be noted: (1) Sicilian big-seeded, blue-flowered seed flax, sometimes grown as a winter variety; (2) big-seeded, white flowered, white-seeded flax; and (3) Indian seed flax, Egyptian seed flax, and Argentine seed flax. The latter are large-seeded varieties of a character almost midway between the Sicilian big-seeded flax and the common Russian seed flax. Each has some qualities distinguishing it more or less definitely.—(F. B. 274.)

Climatic Conditions.—As far as the growth of the seed crop is concerned, its region of culture may be stated to be similar to that of successful spring wheat cultivation, while the fiber crop is at present produced in regions of heavier rainfall and somewhat cooler and more cloudy skies than those in which spring wheat is usually grown with success. The crop may also be said to possess either general capabilities or varieties and strains which allow of the production of fair crops of seed flax at least to the southern limits of winter-wheat producing regions.—(F. B. 274.)

Soil Selection and Preparation.—Experience shows that flax can be grown in a wide range of soils, although a moist, deep, strong loam, upon uplands, is the preferable soil for this culture. Reference is made in this connection to the soil usually selected in European practice, where it is recognized that in a dry calcareous soil the stalk remains short, while in a heavy, clayey soil greater length is secured, though at the expense of fiber. To raise a good crop and good quality of flax, both for fiber and seed, choose a clean field, free from weeds, where a good crop of wheat or corn could be grown; plow it late in the fall, 7 or 8 inches deep after small grain or corn, and 5 or 6 inches on timothy and clover lands, and roll this last immediately after plowing; but if the land plowed 7 or 8 inches has never been turned so deep before, it ought to be replowed the same way in the spring, or, better, in the fall. When the land is dry enough in the spring, and as a general thing in the West about the 10th or 15th of April, cultivate the field for flax twice crosswise, as deep as first plowed, if praticable; let it lie for a few days, and if the weather is warm pulverize fine and deep; sow with the seeder, having the teeth arranged to work but very lightly, 1½ or 2 bushels per acre of Riga or Belgian seed; harrow once crosswise on the seed, and next day, after the dew is gone and the land is dry, roll it well, and be satisfied you can not fail to raise a valuable crop.

The Use of Fertilizers.—It should be understood as one of the axioms in flax culture that a crop of flax that will scutch out a good quality of salable fiber can not be produced on impoverished lands. The reader is referred back to the practice of Belgium and other European flax-growing countries in this matter, where high fertility is considered of first importance.

On the new lands of the West good crops may be grown for a number of years without manures, though in time fertility must be exhausted and poor crops will inevitably follow. The flax crop of all crops makes heavy demands upon the soil, and for this reason is frequently called an exhaustive crop. It must be so naturally, as flax is usually grown for seed, where the ground is shallow plowed, not cultivated, everything taken from it and nothing returned. The stem of the flax plant is tall and slender, growing rapidly, and the long roots as they push down deeply must have something to feed upon to make vigorous growth and good straw. It is on account of this habit of the plant to extend its roots to such depth in the earth that plowing and fine tilth are so essential; and the roots must find food or the plant will be of slow growth, woody and deficient in fiber, and the product inferior both as to quality and quantity.—(U. S. Fiber Inves. R. 10.)

Crop Rotation.—The feature most observed by all is that on light soils a leguminous crop is of much benefit in preparing the soil for flax culture. If however, the soil naturally possesses much available nitrogen, the flax is placed at as distant a date from the leguminous crop as possible and is usually preceded by grass or hay crops. The most common procedure in all countries seems to place flax in the series after several years of grass and pasture. This seems important when considering escape from destructive action by wilt.—(N. Dak. E. S. B. 71.)

Control of Weeds.—Very little need be said of weeds. It is not supposed that they should be allowed in any carefully grown crop; yet there is probably no crop in which their presence is more pernicious than in flax culture. In the case of the fiber crop they must all be removed from the straw by hand before retting, a very costly process. Their presence in the crop also causes unevenness of growth and maturing, with the associated evils. In the seed crop they occasion by their extra foliage great difficulty in properly drying and curing the seed bolls for thrashing. The greatest difficulty is also experienced in attempting to grade weed seed from flaxseed; and whether the seed is being purchased for oil or for sowing purposes, there must be a loss to the grower on account of the low price obtainable for such inferior seed. As the Russian peasant, even though he pulls the crop by hand, always puts into the seed he sells all of the weed seeds available, and as the seed exported by Russian seed houses is made up of many separate small collections of flaxseed from many different districts, one is apt to find many types of very bad weeds in any importation. Among the destructive weeds sure to be represented in such seed are flax dodder (*Cuscuta epilinum*), cornflower (*Centaurea cyanus*), and many types of mustard, including false flax (*Camelina sativa*) and various species of Roripia.—(F. B. 274.)

Quantity of Seed to Sow.—In sowing for seed and fiber, 1½ bushels is the smallest quantity that should be used, and 2 bushels will be better. Two and three peck sowings, the rule in flax culture for seed, will never give a crop of flax fiber that will return a reasonable profit. Three bushels to the acre is the rule in Europe when a superior fiber is desired, for the more thickly the seed is sown the finer the straw and, other conditions being equal, the higher the grade of fiber that will be yielded. In the reports of experience the range was shown to be from 3 pecks to 2½ bushels.—(U. S. Fiber Inves. R. 10.)

Seeding Time.—This is always essentially the same in all regions. The seed is sown as soon in the spring as the work can be accomplished and not have the young plants injured by frost. The date varies according to the latitude and climatic features. The rather cool, rapid-growth months of spring and early summer tend to produce long and fine types of fiber. The fiber plant can not withstand the hardening influence of the high dry heat of the late summer months. In the case of the seed crop the same features will be found to hold true in regions having a long dry summer season. Northward and northwestward in America, including the Dakotas and Minnesota, the crop may be sown with hope of success even until the 10th or 20th of June, as the crop often takes on a very heavy growth in the cool autumn days. In North Dakota, if the late crop is not caught by early frosts, the yield is apt to be even greater than that from the early sown crop, which at times may be compelled to ripen too rapidly by the action of heat in August. The early crop also seems to be more often injured by rust. However, the date of seeding in North Dakota can not be much earlier than May 20 or later than June 20 without loss from frost.

Seeding Methods.—They are as various as the people who grow the crop. The larger areas of the Netherlands and Belgium are seeded with ordinary grain drills, and such machinery is also used upon the largest estates in Russia where the crop is grown for oil production. Small areas in all countries are seeded by hand broadcast and harrowed in. Many fiber growers contend that this method gives best results. Russian peasants broadcast by hand almost exclusively. If evenly cast it is supposed that all straws are shaded alike, and therefore mature evenly as to fiber. The chief merits of any method of seeding must depend upon three points: The seed should be imbedded at an even depth, not too deeply, and should be evenly distributed. The brush harrow, as commonly made by American farmers, gives good results when properly handled, but no scheme of broadcast seeding can give the regularity of depth that yields best results with this crop.—(F. B. 274.)

Treatment of the Seed.—Diseases, such as flax wilt, which affect the roots of the crop may be carried by the seed. Therefore, the seed should be treated with formaldehyde prior to seeding, in order to kill all germs of this disease. The ordinary methods used for grain are not applicable for flax. A treating solution should be made by using 1 pound (16 ounces) of 40 per cent formaldehyde in 40 gallons of water. The solution should always be made up fresh. One-half gallon of this solution is sufficient for one bushel of seed. Forty gallons will treat about 100 bushels. One ounce of formaldehyde in 2½ gallons of water will make a solution of the same strength.

After the seed has been thoroughly cleaned, one method is to pile it on a tight floor or canvas. About five bushels makes a convenient pile. Sprinkle the pile with the thoroughly mixed formaldehyde solution, using a common garden watering pot or some form of spray pump. Shovel the pile over as concrete is mixed. Sprinkle and shovel, sprinkle and shovel, until the entire outside of all the seed is moistened, using up at least ½ gallons of the solution for each bushel of flax seed. Cover the pile with old blankets or gunny sacks and allow to stand for at least two hours. Then, unless planting is done at once, the seed should be spread out to dry, to prevent heating. The treatment will kill all disease spores adhering to the seed.—(Colo. E. S. Cir. April, 1911.)

Harvesting for Seed.—The crop is best harvested with the self binder. The bundles should be set in small loose shocks to permit of thorough drying. Just as soon as it can be safely done, the crop should be thrashed, in order to get the highest quality of seed for market. Flax is sometimes cut with the self-rake or with the binder without twine. In this case, the bunches are left on the ground to cure or dry the straw. This is not as good a practice as binding because of the danger of producing moldy seed, thus lowering the market value. Binding is by far the best method of cutting. Seed flax should be saved from the best, most uniformly ripened portion of the field. Only very plump seed should be kept.—(Colo. E. S. Cir. Apr. 1911.)

Seed Demand.—The demand for flax seed arises from the demand for linseed oil. The by-products of oil manufacture, oil cake and oil meal now have a distinct value. Linseed oil is used in paint, oilcloth, linoleum and many other articles commonly in use. As yet no satisfactory substitute has been found for linseed oil. According to good authority, the industries of the United States use annually about 20,000,000 to 25,000,000 bushels of flax. They could and would use 30,000,000 bushels if they could get the seed.

Harvesting the Fiber.—As to the special mode of harvesting the crop, nearly every experimenter states that the straw was pulled. This is not the usual practice of the Western flax grower, who cultivates for seed, however, and it has been urged that it is absolutely essential, where the object is to produce both fiber and seed, or, to state it more precisely, when the object is to produce a common grade of fiber and at the same time save the seed. If the land surface is made very smooth, so that the knives or the reaper may be set low, cutting by machine (rather than pulling) may answer. Several inches of the best portion of the stem will be lost and the square ends of the fiber will not work into the "sliver" as smoothly as pulled flax when the fiber is being manipulated in the first stages of manufacture.—(F. B. 27.)

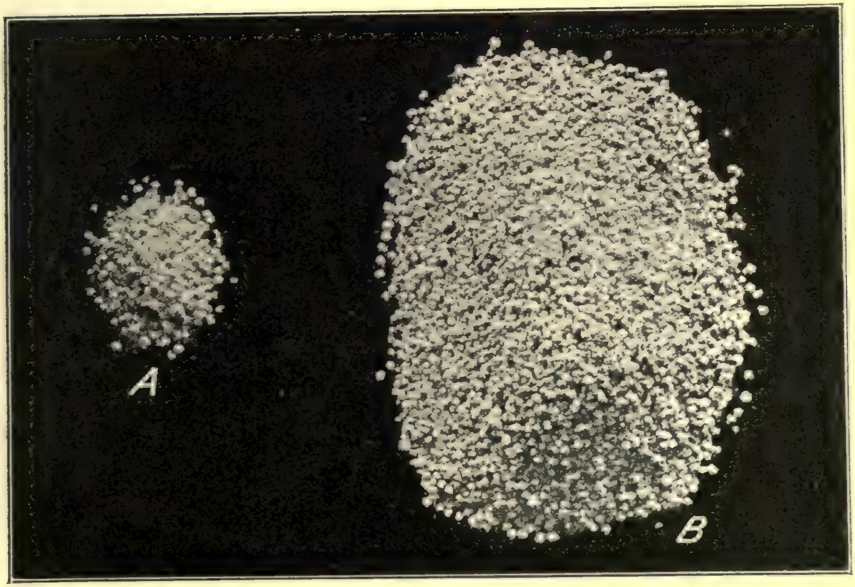
Summary Notes on Flax.—1. Flax does not remove an excessive amount of fertility from the soil. An average yield of fifteen bushels of flax per acre will remove less fertility from the soil than one hundred and fifty bushels of potatoes, forty-five bushels of corn or thirty bushels of wheat.

2. Flax is a weak feeding crop, possessing but little power of obtaining its food from the soil. It absorbs the larger portions of its nitrogen, phosphoric acid and potash during the first forty or fifty days of its growth. In order to supply the food in so short a time the soil must be in a high state of fertility. Raw stable manure, applied directly, is unsuited to flax because the plants are incapable of feeding upon such crude forms of food. In order to be beneficial the manure must be applied to the preceding crop, as corn, so as to become thoroughly rotted and mixed with the soil.

3. Home grown flax seeds are equally as rich in stored up plant food as imported seeds. There is only a slight difference in chemical composition between home grown and imported seed.

4. The best flax soils are composed of sand, silt and clay in the following proportion: one-fourth medium sand, one-fourth fine and very free sand, one-third silt, usually spoken of as clay, and about one-eighth of the finest clay. Any soil capable of producing a good

A YOUNG VINEYARD ON A ROLLING HILLSIDE IN CALIFORNIA. DEPT. OF AGR.



AVERAGE SEED YIELD OF HEALTHY AND CURLY-TOP SUGAR BEETS.
(*A*) AVERAGE AMOUNT FROM DISEASED BEETS.
(*B*) AVERAGE AMOUNT FROM HEALTHY SEED BEETS.

corn crop can be made to produce a good flax crop. Extremely sandy or heavy clay soils are both unsuited to flax.

5. When flax is cut on the green side, after bloom and before seed development, and cured as hay, it makes a valuable fodder, rich in protein, and containing about the same amount of fiber as timothy hay. Flax straw is richer in protein than either wheat, oat or barley straw.

6. A yield of fifteen bushels of flax will produce about 315 pounds of total oil, yielding from 270 to 280 pounds of crude linseed oil by the pressure process.

7. Linseed meal, the product obtained in making linseed oil, is a valuable food, rich in protein which is easily and quite thoroughly digested. The manure from linseed meal fed pigs is very concentrated and rich in nitrogen. If six hundred pounds of linseed meal were fed for every fifteen bushels of flax sold and a good rotation of crops followed, flax raising would then be a means of keeping up the fertility of the soil. When only the oil is sold there is but little fertility lost from the farm.

8. In the raising of flax, the fact that flax will not thrive on the same soil where it has been grown for at least five years previously should be kept in mind, because the flax straw and roots in their decomposition produce products which will destroy a following flax crop. When five or seven years intervene between two flax crops, then the old straw and crop residue is thoroughly decomposed and will not injure a new flax crop. For successful flax raising on soils worn by grain cropping, a liberal use must be made of farm yard manure so as to bring the land up to a high state of fertility. The manure should be applied to corn crops, and not direct to the flax, then a good yield of flax can be obtained and no injury to the soil will follow.—(Minn. E. S. B. 47.)

Conclusions.—The farmer has little incentive to grow flax or fiber until a market is assured, and a market can only be assured when scutch mills have been established to take the product off his hands when grown, and put it into a marketable condition. There should be good scutch mills, not tow mills, in every flax-growing locality. With the establishment of these mills in considerable numbers, the farmer will be ready to raise flax for fiber as well as seed, the manufacturers will avail themselves of the home supply, and the industry will be placed on a substantial footing.

Additional References.—N. Dak. E. S. B. 55; Y. B. 1894, 1895, 1897, 1903; Mont. E. S. Cir. 6, (1911); U. S. Fiber Inves. R. 4.)

THE CULTIVATION OF HEMP.

Hemp (*Cannabis sativa*) is an annual plant of the mulberry family, cultivated for the production of a soft bast fiber. This fiber, gray if dew-retted, or light yellow if water-retted, is also called hemp. In a strict sense the name "hemp" is correctly applied only to this plant and its fiber.

Most of the hemp cultivated in this country, amounting to from 15,000 to 20,000 acres annually, is grown in the bluegrass region of

Kentucky, of which Lexington is the center. About 600 acres are grown each year near Lincoln, Nebr., and an area of about the same size in the lower Sacramento Valley in California. During the past two years hemp has been grown successfully at Kouts and North Liberty, Ind., and at Hanover, Pa. It has also been grown experimentally in Wisconsin, Michigan, Minnesota, Iowa, and Arkansas.

Climate.—Hemp requires about 110 days for its growth. It should have a rainfall of at least 10 inches during this period. It has not been grown commercially under irrigation. If the level of free water in the soil is within 5 to 10 feet from the surface, as is often the case in alluvial river-bottom lands, and the character of the soil is such that there is good capillary action to bring the water up, hemp will not suffer from drought, even should there be very little rainfall. Hemp is uninjured by light frosts. It may therefore be sown earlier than oats and harvested later than corn.

Soil.—Hemp requires for its best development a rich, alluvial, or loamy soil not subject to severe drought, yet not of a swampy condition. It is not to be recommended for a light sandy soil, unless it follows a crop of clover or beans which has left a plentiful supply of nitrogenous fertilizer. The soil should also be well supplied with lime. Hemp will not grow well in an acid soil or on gumbo soils. Excellent crops have been obtained in Indiana on peaty soils over marl.

The best fertilizer for the hemp crop is barnyard manure, and this should be applied to the previous crop or, at the latest, in the fall before sowing the hemp. Hemp may be introduced in any crop rotation, but it is best to have it follow peas, beans, or clover. It may follow corn or grain, providing these crops are well fertilized. A dense growth of hemp destroys nearly all weeds, and as it is a rather deep rooting plant and shades the soil it leaves the land in excellent condition for any crop which may follow.

Sowing.—Hemp seed should be sown at the rate of approximately 1 bushel per acre at about the time of sowing oats or as early as possible after the period of severe frosts. If possible the land should be plowed during the previous fall. Fall plowing is essential for success if a heavy sod or much vegetation is to be turned under. The soil should be harrowed at least once before seeding in order to settle the furrows.

The seed is sown broadcast by hand or by any good broadcast seeder set for seeds smaller than average grains of wheat. Good results are obtained with an end-gate seeder, a roller-press grain drill, or an ordinary toothed grain drill with the teeth removed and replaced by a board dragging on the ground below the feeding tubes. The seed falling on this board will be spread out evenly over the surface. The ordinary teeth cover the seed too deeply and crowd them in drills from 6 to 8 inches apart, so that the hemp does not grow as evenly as when it is spread over the entire surface. The seed may be covered by means of a light straight-toothed harrow. Drills similar to grain drills are made especially for sowing hemp seed and are largely used in Kentucky. These hemp-seed drills will be found

Breaking Hemp on Hand Break.

Cutting Hemp by Hand.

most economical if large areas of hemp are to be sown or if hemp is to be raised year after year as a regular crop.

After seeding it is best to roll the land in order to have a smooth surface that will permit close cutting with machinery. After seeding, the crop requires no further attention until harvesting.

Harvesting.—Most of the hemp is now cut with self-rake reapers made especially for harvesting this crop. These machines require 2 men, or a man and a boy, and 4 horses for their operation and 1 man to keep the knives sharp. They cut a swath of about 5 feet, or about 5 or 6 acres per day. They leave the hemp stalks in gavels. After lying in the gavel for two or three days the stalks are either spread for retting, set in shocks without binding, or tied in bundles and set in shocks. When the harvest is late, or in the North, where there is little danger of hot dry weather that would "sunburn" the stalks, labor may be saved by spreading the hemp for retting immediately after cutting. If there is danger of hot dry weather after harvest the hemp should be cured in shocks. If it is to be stacked it must be bound in bundles before shocking. Stacking is not regarded as a necessary step in the preparation of hemp, but a greater weight and also a better quality of fiber are obtained from stalks which have been stacked. If the stacks are properly made they may be left almost indefinitely before retting. Three men will put up two stacks a day of about 8 tons each.

In Nebraska the hemp is cut with a mowing machine with a special homemade attachment, bending the stalks over in the same direction that the machine is cutting. One man with one span of horses will cut from 7 to 9 acres per day. The ordinary price paid there for cutting hemp is 50 cents per acre, including team and machine. The hemp is left on the ground as it falls until retted, when it is raked up with a horserake and hauled to the machine brake to be made into long tow.

Retting.—Practically all of the hemp produced in Kentucky is dew-retted. It is spread on the ground, either from the gavel, shock, or stack, in rows with the stalks side by side and not more than two, or at most three, stalks in thickness, the butts all even and in one direction. It is left in this manner for from four to twelve weeks, or sometimes even longer, until the bark, including the fiber, separates readily from the woody portion of the stalk. The stalks are then raked up and set up in shocks to dry. As soon as dried they are ready for breaking.

Breaking.—Much of the hemp produced in Kentucky is still broken by the old-fashioned hand brake, but this method is not recommended for introduction into any new locality because it requires a degree of skill that would be difficult to secure in laborers not accustomed to the work. Even in Kentucky the newer generation of laborers do not learn to break hemp, and this is one of the principal reasons that the industry is not carried on there to any greater extent. At least six different kinds of machines for breaking hemp and preparing the fiber have been in use during the past three years, and some of these prepare the fiber very much better than the hand brake.

At Havelock, Nebr., and at Courtland, Cal., there are power machines consisting essentially of a series of fluted rollers, somewhat like a jute softener, followed by large beating wheels, and these machines make long tow. They will handle a greater variety of different-sized hemp stalks in a satisfactory manner than the other machine brakes, but as the fiber is tangled instead of being straight it does not command as high a price as that produced by the hand brakes or by the other machine brakes mentioned.

Yield.—The yield of hemp fiber ranges from 500 to 2,000 pounds to the acre. The general average yield under ordinary conditions is about 1,000 pounds to the acre. Yields are sometimes estimated at 150 pounds of fiber for each foot in height of the stalks, and also at 20 per cent of the weight of the dry, retted stalks, but estimates based on these factors alone may be misleading, for slender stalks yield much more fiber than coarse ones.

Market.—All of the hemp fiber produced in this country is used in American mills, and increasing quantities are being imported. It is used for making gray twines, commercial twines, carpet warp, and ropes of small diameter.

The average price paid during the last twenty years by local dealers to the farmers in Kentucky for the rough fiber tied up in handmade bales has been about 5 cents a pound. The prices during the same time for the fiber sorted, pressed in bales, and delivered at the mills as ordered have ranged from $130 to $175 per long ton. The market is occasionally overstocked with low-grade hemp or tow, but there is little danger of an oversupply of good, strong, well-cleaned fiber.

Profits.—The following rough outline of expenses and returns may serve as a basis for estimating profits, keeping in mind that there may be considerable variation either way, due to local conditions:

Cost per acre.		*Returns per acre.*	
Seed, 1 bushel, at $4	$ 4.00	1,000 pounds of hemp fiber, at 5 cents	$50.00
Plowing	2.50		
Harrowing once	.50		
Sowing	.75		
Harrowing (omitted if special drill is used)	.50		
Rolling	.50		
Cutting	1.00		
Shocking	1.25		
Spreading for retting	1.50		
Picking up	1.50		
Breaking, 1,000 pounds, at 1½ cents per pound	15.00		
Baling and marketing	1.00		
Total cost per acre	$30.00	Gross returns	$50.00

Hemp can not be grown profitably in small isolated areas. Two hundred acres or more should be grown on one or more farms near together, so as to warrant the introduction of special machinery for drilling, harvesting, breaking, and baling, and also make it possible to ship the fiber in full car lots. Before undertaking the cultivation of hemp on a commercial scale it is advisable to try some preliminary experiments with half an acre or less, to determine whether the local conditions are adapted to the crop.—(B. P. I. B. Cir. 57.)

(*Additional References.*—Y. B. 1895, 1903; U. S. Fiber Inves. R. 6, 8, 11; U. S. E. S. R. 1.)

RAMIE.

Probably no fiber in the vegetable economy has attracted such widespread interest as ramie, for nearly every government on the face of the globe, in countries where the plant will grow, has encouraged the establishment of the industry in one form or another, or capitalists in these countries have liberally aided invention and private experiment in the hope of securing the golden reward it has offered. Through these unremitting efforts, and the lavish use of private capital, there is now a flattering prospect that the industry will ere long be fairly established, and ramie fabrics will be found in the markets of the world side by side with those from silk, from cotton, and from flax. European concerns even now are running thousands of spindles, turning out hundreds of tons of yarns annually, and are enlarging their works.

Ramie is a plant belonging to the nettle family (*Urticaceæ*), which from time immemorial has been cultivated in China, and known to botanists by the name *Bœhmeria nivea,* frequently called the stingless nettle. It is also known as "China-grass" and "Rhea." It has long been cultivated, also, in Japan, in Java, Bornea, Sumatra, and in the East Indies, and during the present century has been introduced into other countries. Its introduction into the United States dates back to the year 1855.

When fully grown the plant attains a height of 4 to 8 feet, clothed with large ovate-acuminate leaves that are green above and whitish or silvery beneath, the fiber being formed in the bark which surrounds the stalk, this having a pithy center. It is of rapid growth and produces from two to four, or even five, crops a year without replanting, dependent upon the climate where cultivated. In China and Japan, where the fiber is extracted by hand labor, it is manufactured not only into cordage, fish-lines, nets, and similar coarse manufactures, but woven into the finest and most beautiful of fabrics. In England, France, and Germany the fiber has also been woven into a great variety of fabrics, covering the widest range of uses, such as lace, lace curtains, handkerchiefs, cloth, or white goods resembling fine linen, dress goods, napkins, table damask, table-covers, bedspreads, drapery for curtains or lambrequins, plush, and even carpets and fabrics suitable for clothing. The fiber can be dyed in all desirable shades or colors, some examples having the luster and brilliancy of silk. It is one of the strongest and most durable of fibers, is least affected by moisture of all fibers, and from these characteristics must take first rank in value as a textile substance. It has three times the strength of Russian hemp, while its filaments can be separated almost to the fineness of silk. In manufacture it has been spun on various forms of textile machinery, and also used in connection with cotton, wool, and silk, and it can be employed as a substitute in certain forms of manufacture, where elasticity is not essential, for all of these textiles, and for flax also. It likewise produces superior paper, and can be utilized in the manufacture of celluloid. In short, the uses to which it may be put are almost endless, and when the economical extraction of the fiber by machinery is successfully accomplished, it will become one of the most valuable commercial products of the vegetable kingdom.

Ramie is a plant of easy cultivation. It has been grown as far north as Pennsylvania and New Jersey, though for the production of fiber its culture succeeds best in the Southern States, and particularly those bordering the Gulf of Mexico. It also thrives well on the Pacific coast, having been grown with success experimentally in California for several years.

The plant is propagated by seeds, by cuttings or by layers, and by division of the roots. When produced from seed the greatest care is taken with the planting, as the seed is very small. For this reason open air planting can hardly be relied upon, plants started in the hotbed giving the best results. After planting, the seeds are covered thinly with sifted earth and kept shaded from the sun until the young plants are 2 or 3 inches high, when sunlight is gradually admitted to them. In five or six weeks they will be strong enough to transplant to the field.

By far the most practical method and the one which will give the best results in this country, is the propagation by a division of the roots of old or fully matured plants. The old plants are better than young ones for the purpose as the root-mass is larger, the tuberous portions showing a greater number of eyes and therefore giving stronger plants after division. The practice varies as to distance apart that these are planted. In India 4 feet apart each way is considered the proper distance, though in France some favor 2 feet apart each way.

The plants are given cultivation at first, being hilled like corn or potatoes, all weeds being kept down, though after getting a good start, from the rankness of their growth and the density of the foliage, weeds will have little chance to grow. These brief directions are sufficient to enable any one to make a beginning; experience and a familiarity with the plant and its manner of growth will suggest subsequent treatment and assist the farmer in establishing the particular practice that it will be best for him to follow. Southern cultivators choose a deep, rich, light, and moist soil.

A rich loam suits the plants best, but they will grow in any kind of soil, provided a full supply of moisture be available, combined with thorough drainage.

If sufficient moisture cannot be assured it should be supplied by irrigation, a positive essential in many localities where ramie is grown. It must be remembered, however, that ramie will not thrive in a wet soil. The ground must be well prepared by plowing to the depth of ten inches, and well pulverized, and if the land is poor fertilizers must be applied to bring it up to a good state of fertility. All weeds must be removed from the soil or they will sorely plague the cultivator in the first year or so until the plants have grown large. When the climate will admit of producing three crops a year, the cuttings are made at intervals of about ten or twelve weeks, the first cuttings to be made about the middle of May, dependent on the season.

Status of the Ramie Industry.—In order for the farmer to understand the present position of the ramie industry it would be useful to adopt some kind of classification of the details connected with it. In the first place there is the mere business of cultivating the ramie plant, and of producing stems with the fiber in the best possible condition. This is purely the work of the planter. Secondly, there is the process or processes necessary to separate the fiber from the stems in the form of ribbons and filasse. It is necessary for many reasons that this should be done either by the planter on the spot or by a central factory close at hand. Thirdly, there is the purely technical and manufacturing process in which ramie filasse is taken up by the spinners, and utilized in the same manner as cotton, flax and silk are utilized for the purpose of being made into fabrics.

For the present purpose it may be taken for granted that the cultivation of the ramie plant presents no insuperable difficulty. Also that if a suitable selection of soil is made, and the locality possesses the necessary climatic conditions as regards heat and moisture, there is no reason to doubt that ramie could be grown to greater or less extent in most of the Southern States. As regards the second stage, in which is involved the decortication of the ramie stems, the problem is by no means completely solved.

On this really hangs the whole subject. The third stage is disappointing and unsatisfactory because the second stage is still uncertain, and being thus uncertain the fiber is necessarily produced in small and irregular quantities, and only comes into the market by fits and starts. It would appear that ramie fiber differs so essentially from cotton and flax that it can only be manipulated and worked into fabrics by means of machinery specially constructed to deal with it. Owing to the comparatively limited supply of ramie fiber hitherto in the market no large firms of manufacturers have thought it worth while to alter the present or put up new machinery to work up ramie fiber. If appliances or processes for decorticating Ramie were already devised, and the fiber came into the market regularly, and in large quantities—say hundreds of tons at a time, there is no doubt manufacturers would be fully prepared to deal with it. At present the industry is practically blocked by the absence of any really successful means of separating the fiber from the stems, and preparing it cheaply and effectively. This after all is the identical problem which has baffled solution for the last fifty years. There is no question but that ramie culture will pay well when the industry is fairly established; and the very fact that it will prove so remunerative will spur to greater effort to overthrow all remaining obstacles. —(U. S. Statistical R. 1.)

JUTE.

Jute fiber is obtained from two closely related species, *Corchorus olitorius* and *Corchorus capsularis,* native in Asia. Both are cultivated largely in Bengal, India, and to a less extent in China, Japan, and Formosa. The plants are annuals, belonging to the linden family. In general habit of growth they resemble Kentucky hemp, attaining a height of 8 to 12 feet, with no branches or only a few small ones near the top. Jute grows best in rich alluvial soils along rivers. The seed is sown in the spring, either broadcast in the field or sometimes in carefully prepared beds, from which the seedlings are afterwards transplanted. The plants are harvested either by cutting close to the ground or by pulling them up by the roots. In Formosa the fiber is stripped from the fresh green stalks as soon as pulled, and these ribbons, called "hemp skins," are afterwards retted by soaking them in water, and the fiber cleaned by drawing it between a blunt knife and a block of wood. In India the jute is either cut or pulled, and is retted by immersing the bundles of stalks in water. The fiber is afterwards cleaned by hand processes from the wet stalks.

The coarser fiber from the base of the stalks, 5 to 25 inches in length, is cut off and placed upon the market as jute butts. The remainder of the fiber is fine, soft, glossy, pliable, and easily spun. When fresh it is of a light creamy-white color, but it changes to a dingy yellow upon exposure. It also loses its strength, especially if exposed to moisture. It is the cheapest fiber used in American textile manufactures, and it is employed in greater quantities than any other except cotton and sisal. Jute butts, ranging in price from 1 to 2 cents per pound, are used for making paper, and also for coarse bagging, cotton-bale covering, and the cheaper grades of twine. The longer fiber is used for wool twine, binder twine, jute rugs and carpets, grain sacks, and even for filling in heavy silk goods. The importations of jute fiber and jute butts amount to more than 100,000 tons a year, and the consumption in this country is steadily increasing. Experiments in the cultivation of jute in this country have proved that the plants may be grown successfully in the Southern States, but without suitable machinery for preparing the fiber the industry can not be carried on profitably. A machine that will decorticate ramie will strip jute, and probably, with some slight changes, other bast fibers. The problem which has confronted the world with regard to ramie is almost identical, therefore, with that which has proved the stumbling block of the jute industry and other good fibers as well.—(Y. B. 1903.)

MANILA HEMP.

Abaca plants, from which comes the Manila hemp used for binder twine, are cultivated successfully only in a comparatively small portion of the Philippines. In appearance they resemble the common fruit banana. In these regions there is an abundant rainfall and a relatively high humidity of the atmosphere. The plant grows best in volcanic soils on hillsides where there is good natural drainage. It cannot be grown successfully in wet, swampy land or in soil that becomes dry. The plants are propagated chiefly by suckers, which spring from the roots of mature plants. These are set out in rows 5 to 8 feet apart in each direction. Cultivation consists chiefly in cutting down weeds which would otherwise grow up and choke out the abaca. About three years are required for the plants to reach maturity when propagated from cuttings, or about five years when grown from seeds. They attain a height of 8 to 20 feet, the trunk being composed chiefly of overlapping leaf sheaths. When the flower bud appears the entire plant is cut off close to the ground. The leaf sheaths, 5 to 12 feet in length, are stripped off, separated tangentially into layers a quarter of an inch or less in thickness, and these in turn split into strips 1 to 2 inches in width. While yet fresh and green these strips are drawn by hand under a knife held by a spring against a piece of wood. This scrapes away the pulp, leaving the fiber clean and white. After drying in the sun the fiber is tied in bunches and taken to the principal towns or to Manila to be baled for export.

The average yield of fiber is about 650 pounds per acre.

The best grade of manila fiber is of a light buff color, lustrous, and very strong, in fine, even strands 6 to 12 feet in length. Poorer grades are coarser and duller in color, some of them yellow or even dark brown, and lacking in strength. The better grades are regarded as the only satisfactory material known in commerce for making hawsers, ships' cables, and other marine cordage which may be exposed to salt water, or for well-drilling cables, hoisting ropes, and transmission ropes to be used where great strength and flexibility are required. The best grade of binder twine is made from manila fiber, since owing to its greater strength it can be made up at 650 feet to the pound as compared with sisal at 500 feet.

SISAL.

The sisal plant (*Agave rigida*) usually known as henequen in Spanish-speaking countries, is native in Yucatan. It has been introduced in many other tropical countries, but its cultivation for fiber on a commercial scale is confined to Yucatan, the Bahamas, Turks Island, Cuba, and Hawaii. The sisal plant requires for its best development a soil composed chiefly of limestone and a warm and comparatively dry climate. Clear, dry weather, with bright sunshine, is required to dry and bleach the fiber, while in rich, moist soil or in a moist climate the leaves develop too large an amount of pulp in proportion to the fiber.

The sisal plant is propagated by suckers springing from the roots of old plants, or from bulbils. Bulbils, called "mast plants," are produced in great numbers on the flower stalks in place of seed pods, like onion sets. The plants are set out during the rainy season, in rows 4 to 8 feet apart, in holes dug in partly disintegrated coral or lime rock with crowbars, pickaxes, and sometimes with the aid of dynamite. The ground where sisal is grown is usually too rocky to permit any stirring of the soil. About the only care given is to cut the brush and weeds once or twice each year. The weeds and brush, largely leguminous plants, by decaying on the ground add fertility to the soil. The first crop of outer leaves of the plants is cut at the end of three years when grown from suckers, or four years when grown from mast plants. From ten to twenty leaves are produced each year for a period of twelve to twenty-five years in Yucatan, ten to fifteen years in Cuba, and six to twelve years in the Bahamas. An unusually cold winter at any period tends to check growth and cause the plants to send up flower stalks, after which they die.

Sisal fiber is cleaned from the leaves by machines which scrape out the pulp and at the same time wash the fiber in running water. It is then hung in the sun to dry and bleach for from one to three days, after which it is baled for market. The average annual yield is about 600 pounds of clean, dry fiber per acre.

Sisal fiber of good quality is of a slightly yellowish-white color, 2½ to 4 feet in length, somewhat harsher and less flexible than manila fiber, but next to that the strongest and most extensively used hard fiber. It is used in the manufacture of binder twine, lariats, and general cordage, aside from marine cordage and derrick ropes. It can not withstand the destructive action of salt water, and its lack of flexibility prevents it from being used to advantage for running over pulleys or in power transmission. It is used extensively in mixtures with manila fiber.

NEW ZEALAND HEMP.

The plant producing the fiber known in the markets as New Zealand hemp or New Zealand flax is a perennial belonging to the lily family, and is technically known as *Phormium tenax*. It is native in the coast regions of New Zealand, and is cultivated commercially only in those islands. The plant is hardy, withstanding a considerable degree of cold and drought. It is cultivated as an ornamental plant in parks and private grounds in the coast region of California, and also on the west coasts of Ireland and Scotland. Several different varieties are cultivated in New Zealand, some with leaves 6 to 8 feet long, others with leaves only half that length, 1½ to 3 inches in width, and of rather thin texture. The fiber is cleaned from the freshly cut leaves by scraping, washing, and drying. The scraping process is performed chiefly by machinery, but no machine has yet been used which will do all of the work satisfactorily.

The fiber is 40 to 60 inches long, nearly white, fine, and rather soft for a leaf fiber. It is used as a substitute for sisal in binder twine, baling rope, and medium grades of cordage, and is made up largely in mixtures with manila or sisal, except in the cheaper tying twines. By extra care in preparation and hackling, a quality is produced almost as fine and soft as the better grades of flax, and when thus prepared it may be spun and woven into goods closely resembling linen.

MAURITIUS.

Mauritius fiber or mauritius hemp, as it is often called in the market, is obtained from the large, fleshy leaves of an agave-like plant (*Furcræa fœtida*). This plant is widely distributed in the tropics of both hemispheres. In Porto Rico it is known as maguey, probably from its resemblance to the maguey of Mexico, and in Hawaii it is called malino, a corruption of manila.

The fiber is produced commercially only on the island of Mauritius, though there seems to be no good reason why the industry should not succeed elsewhere. The plant is more hardy and thrives under a greater diversity of soil and climatic conditions than any other important fiber plant of this class. It is propagated by suckers or by bulbils in the same manner as sisal, and the fiber is cleaned partly by machinery. The preparation of the fiber involves the same processes, scraping, washing, and drying, as in the case of sisal. Under favorable conditions the yield ranges from 1,000 to 1,500 pounds per acre. The fiber is whiter and softer than other hard fibers, but it is weaker than sisal. It is used in the manufacture of gunny bags, halters, and hammocks, but more largely for mixing with manila and sisal in making medium grades of cordage. When the better grades of cordage fiber (manila and sisal) are abundant and quoted low in the market, mauritius is likely to fall below the cost of production.

ISTLE.

The increasing demand for cordage and twines of all kinds during the past few years has led to the substitution of istle fiber for the cheaper grades, whereas this fiber had been regarded heretofore as suitable only for use in the manufacture of brushes. Istle or Tampico fiber is produced by four or five different species of plants which grow on the high arid table-lands of northern Mexico. The most important of these are the Jaumave lechuguilla (pronounced How-mah′-ve lech-u-guee′l-ya), producing the best grade, Jaumave istle, lechuguilla, producing a medium grade, Tula istle; and palma samandoca and palma pita, producing palma istle, about equal in value to Tula istle. The production of Jaumave istle is confined chiefly to the fertile Jaumave Valley, about 70 miles by road over the mountains south of Victoria, in the State of Tamaulipas. The fiber is obtained from the leaves of an agave plant, known technically as *Agave lophantha.* The plant is not cultivated, but it grows abundantly on the mountain sides and out on the gravelly plain at the base of the mountains. Only the young inner leaves, forming the central spindle-like bud, are used. These are collected and the leaves taken up one by one and cleaned by drawing them, first one end then the other, under a blunt knife pressed against a block of wood. More than 30 tons of this fiber are produced in the vicinity of Jaumave every week, and all of it is shipped on the backs of burros over the mountains, a long two days' journey, to the railway at Victoria.

Tula istle is obtained from the lechuguilla plant (*Agave lechuguilla*), which is widely distributed on the high lands of Mexico and extends into western Texas and New Mexico. The fiber is produced most abundantly in the vicinity of Tula, about 60 miles south of Jaumave, in the State of Tamaulipas. It is obtained from the inner leaves of the plant, and is cleaned in exactly the same manner as Jaumave istle.

Palma istle is obtained from the inner leaves of yuccas, known in Mexico as palmas. The species producing most of this fiber is called palma samandoca (*Samuella carnerosana*). This plant has a trunk 6 to 15 inches in diameter, and attains a height of 6 to 15 feet, bearing at the top a dense cluster of sword-like leaves, 20 to 30 inches long. Some of the palma istle is produced by the plant known as palma loco, or palma pita (*Yucca treculeana*), found in Coahuila and Nueva Leon. This yucca is very similar in appearance to palma samandoca, though usually with shorter trunk and longer leaves. The central cluster of unopened young leaves is collected and cleaned in the same manner as the leaves of the lechuguilla plants, except that they have to be steamed two to four hours to loosen the tissues before the pulp can be scraped out. The fiber is discolored by the steaming process, but this is partly corrected by bleaching in the sun as it dries.

Palma istle fiber is 15 to 35 inches in length, usually coarser and stiffer than sisal, yellow in color, and somewhat gummy. Tula istle is 12 to 30 inches long and nearly white in color. Jaumave istle is 20 to 40 inches long, rarely longer, almost white, and nearly as strong and flexible as sisal. Istle fiber has long been used as a substitute for bristles in the manufacture of brushes, and it is now being employed in increasing quantities in the cheaper grades of twine, such as lath twine, baling rope, and medium grades of cordage. Introduced at first as an adulterant or substitute for better fibers, it seems destined to find, through improved processes of manufacture, a legitimate place in the cordage industry. If machines are devised for cleaning this fiber in a satisfactory manner it is thought that the thousands of acres of lechuguilla plants in western Texas may be profitably utilized.—(Y. B. 1903.)

UNCULTIVATED BAST FIBERS.

The indigenous or uncultivated species of plants producing bast fiber in the United States and Canada form an interesting group in the fiber series. They are the subject of constant inquiry, as the masses of their filaments, disintegrated and semi-bleached on the parent stalk by the winter storms often attract the attention of the farmer, who, regarding his discovery as new, and considering it the source of a valuable, undeveloped industry, writes the Department to learn the name and history of the species.

For the most part the species under consideration belong to three large families of plants: The *Malvaceæ;* of which the cotton plant is a member; the *Asclepidaceæ*, and the *Leguminosæ.* The malvaceous species are the most numerous, and possibly the most widely distributed, their fiber possessing fair strength, comparing with jute, rather than with flax and hemp, though whiter in color than the former. These might be considered as "jute substitutes," while the species belonging to the two other families, and which give stronger fiber, may be termed "hemp substitutes," and are, therefore, the more valuable.

That these fibers are not employed commercially is due to several causes, the machine question being an important factor. The facts that flax and hemp can be readily grown over large areas of our country, and that the cultivation of these plants and the manipulation of the fiber are matters well understood, have prevented some of the native forms from being brought into prominence in northern localities favorable to their growth, while the cheapness of commercial jute has kept back the culture of others, particularly in the South, where they might readily be produced.

Nevertheless, some of these species have been regarded with high favor in the Old World, where they have been cultivated to some extent and where the fiber is prepared cheaply, though by primitive methods that could not be adopted in the United States. In these countries the product is usually manufactured in or near the localities of growth and is considered of "local" rather than of "commercial" importance. This indicates a possible utilization of some of the native species; for while it might be difficult to produce fiber that would be marketed with the commercial cordage fibers, small local industries might be established to grow the fiber and utilize it in such manufactures as would enter exclusively into home consumption. For many purposes sisal and manila cordage only can be employed, but, at the same time, considerable quantities of sisal and manila cordage are employed in uses for which the cheaper, home-grown fiber would be just as well adapted.

The first thing to be considered, however, is the question of economical production. What will it cost to grow an acre of stalks, and what will be the expense of stripping and cleaning the fiber? Until these questions can be satisfactorily answered, the cultivation of the fiber must be considered as still in the experimental stage, and it would be unwise to go into the culture expecting sure remuneration.

The malvaceous fibers include the swamp rose mallow, the rozelle hemp plant, the sida fiber, the cotton-stalk fiber, and the foreign species of hibiscus. The okra and abutilon fibers of this group give promise of practical value. Others are the asclepias, or milkweed fiber, the Colorado River hemp, the bowstring hemp, the Indian hemp, the nettles, the common burdock, bear grass (Yucca), and Pineapple fiber. In this connection should also be mentioned the tree bast fibers used by nurserymen.—(U. S. Fiber Inves. Rept. 5 and 6.)

TOBACCO GROWING.

Tobacco was first cultivated in America. The early explorers of this continent found the natives making use of tobacco for smoking, chewing, and medicinal purposes.

Varieties.—Tobacco belongs to the Solanaceæ family, which includes, among other plants, Irish potatoes, tomatoes, red peppers, and jimson weeds. There are more than one hundred varieties of tobacco in cultivation. The leading varieties grown in America are the White Burley, Zimmer Spanish, Cuban, Orinoco, Connecticut Seed Leaf, Yellow Pryor, Havana Seed Leaf, and Sumatra Seed Leaf. —(U. S. E. S. Far. Inst. Lect. 9.)

Description of Varieties.—It is impossible to recommend the best variety of tobacco for growing, that being a matter which can only be determined by careful experiments. If the soil and climatic conditions are known, a study of the description of the varieties will enable the grower to select one which will be adapted most nearly to his conditions. In the following list the best varieties for the growers are grouped with reference to their uses and the character of soil which produces the best yield of each variety, as determined by past experience.

CIGAR-WRAPPER TOBACCOS.

Sumatra.—Used wholly for the production of high-grade cigar wrappers and not considered of any value for fillers. In the United States this variety is grown under slat or cloth shade. Adapted to sandy loam soil. In western Florida, where it is grown extensively, the surface soil is underlaid by a red clay subsoil. The leaves are very thin, of fine texture, with small veins, and vary from 12 to 20 inches in length and 8 to 16 inches in width. The plants bear from 16 to 30 leaves, with comparatively long internodes. The leaves have an erect habit of growth. Under favorable conditions for growth the plants reach a height of from 7 to 9 feet. This variety produces the best grade of domestic cigar wrappers. Grown in western Florida, in southern Georgia, and in the Connecticut Valley.

Connecticut Havana.—Used for cigar wrappers and binders, and the top leaves are frequently used for fillers in the inferior grades of domestic cigars. Adapted to light alluvial, sandy soils, containing a small percentage of clay, and as a rule the less the clay the higher the yield of fine cigar wrappers. Where this variety is grown for fillers a rich clay yielding a heavy crop of leaf is probably the most desirable type of soil. The leaves are thin, of fine texture and delicate flavor, set very close together on the stalk, with very short internodes, and have a very erect habit of growth. The plants bear from 10 to 15 leaves, varying in average length from 20 to 32 inches and in average width of from 10 to 15 inches. This variety was secured by continued seed selection from crops grown from seed imported from Cuba, and is probably a cross between these Cuban plants and the native Broadleaf of the Connecticut Valley. Grown in the Connecticut Valley, Wisconsin (mainly for binders), Ohio, Pennsylvania, and New York. One of the best general-purpose tobaccos.

Connecticut Broadleaf.—Formerly known and generally recognized in the trade as Seedleaf. Used for cigar wrappers and binders and the lower grades, to a limited extent, for blending with other tobaccos for cigar fillers. Adapted to sandy loam soil. This variety makes an exceedingly rapid growth. The leaves are very broad, sweet tasting, thin, elastic, silky, and with small veins. The leaves are set very close together on the plant, having a very characteristic drooping habit of growth, and vary in length from 24 to 36 inches and in width from 12 to 22 inches. The size of leaf varies greatly in different sections and with the different strains which have been developed by individual growers. The seed of this variety has been sent to many sections of the United States and a large number of important varieties have been secured from this source, as in the case of the Ohio Seedleaf, which can be traced directly to Connecticut Broadleaf seed. Grown in the Connecticut Valley, New Hampshire, Vermont, New York, Pennsylvania, Ohio, Wisconsin, Minnesota, and to a slight extent in Indiana and Illinois.

CIGAR-FILLER TOBACCOS.

Cuban.—Used for high-grade cigar wrappers when grown under shade, but is generally grown outside for cigar fillers. Adapted to alluvial or sandy soil resting on red clay subsoil. This variety has a small leaf of fine texture. The leaves are short and round, with small veins, medium to heavy body, varying from 10 to 18 inches in length, and 6 to 14 inches in width. When this variety is taken north the influence of the climate and soil conditions tends to promote the development of a large leaf at the expense of fineness of texture and quality. When grown from freshly imported seed in southern tobacco districts the tobacco seems to retain the valuable qualities of flavor, aroma, smooth taste, and other characters of the imported Cuban tobacco. Whether these qualities can be retained by continued selection of seed from desirable plants is a subject for experimentation, but the evidence obtained up to this time indicates that it is probable that in certain districts in the United States uniform crops of Cuban tobacco having a highly desirable flavor and aroma can be produced by the aid of systematic seed selection. In the Connecticut Valley this variety is grown under shade for cigar wrappers, the top leaves being used to a limited extent for cigar fillers, and it is grown for cigar fillers in Florida, Texas, Ohio, and Georgia. In Florida and Texas it produces one of the best grades of domestic fillers.

Zimmer Spanish.—Largely used for cigar fillers, and is the most popular and extensively grown domestic filler. It is frequently used for blending with other tobaccos in cigar fillers. It is commonly believed to be a hybrid of the native Seedleaf and the Cuban variety. Adapted to light loam soil, and in the Miami Valley, Ohio, where this variety is most extensively grown, the surface soil is underlaid by a red-brown clay loam. The leaves are medium in size, have good body and elasticity, with small veins, and they resemble the Cuban variety. The leaves are set close together on the stalk, from 14 to 20 leaves to the plant, the plants reaching an average height of about 4 feet. This variety produces an average yield of about 600 pounds to the acre. Grown in Ohio and Wisconsin.

Little Dutch.—Used for cigar fillers, making a cigar with an aroma resembling the Yara tobacco grown in eastern Cuba. Adapted to clay loam soils. The seed was introduced in this country from Germany. The leaves are small and narrow and the plants have a short habit of growth, producing a light yield. This tobacco requires careful curing and fermentation. Grown in Ohio and to a limited extent in Pennsylvania.

PIPE TOBACCOS.

North Carolina Bright Yellow.—Used for manufacturing plug and smoking tobaccos, cigarettes, and for export purposes. This variety is adapted to sandy soils, underlaid by a red or yellow clay subsoil. The deeper the sand the brighter the tobacco produced, and the nearer the surface the subsoil comes the more inclined the tobacco is to darken in color. The leaves are light and spongy, of rather thick texture, set close together on the stem, with an erect habit of growth, but drooping at the ends, the tops often touching the ground. This variety is a modified type of the native Maryland and Virginia tobaccos. Grown in North Carolina, Maryland, Virginia, and South Carolina.

Maryland Smoking.—Used for manufacturing and export purposes. Adapted to clay loam and sandy soil. The leaves are thick and coarse in texture, but are light and chaffy when cured. They have a semi-erect habit of growth, drooping at the tips, varying in length from 20 to 36 inches and in width from 10 to 26 inches. The plants bear from 10 to 18 leaves and reach an average height of about 4 feet. This variety was discovered in Maryland when the first settlers explored that region. It is mostly exported to France, Germany, and Holland. Grown in Maryland, Virginia, and Pennsylvania. From the Maryland tobacco many of the important native varieties have been developed by growing in different tobacco-growing sections and by continued selection of seed for a particular type of tobacco.

PLUG TOBACCOS.

White Burley.—Used for plug fillers and wrappers for smoking and for the manufacture of cigarettes. Adapted to well-drained, deep red, clay loam soil. In Kentucky such soils are fairly rich in lime and produce good crops of corn, wheat, hemp, and grass, but they deteriorate rapidly unless the fertility is maintained by the use of fertilizers and proper methods of cultivation. The leaves are long and broad and have a white appearance in the field. They have a horizontal habit of growth, the tips hanging down and often touching the ground. They vary in length from 28 to 36 inches and in width from 16 to 24 inches. The plants bear from 10 to 18 leaves and reach an average height of about 4 feet in the field. This variety is a selection from the original Burley, the peculiar white, translucent appearance of the original parent plant having attracted the attention of the growers. Seed saved from this plant produced a large number of plants the following season, and in time a large and important industry was developed from this beginning. The Red Burley and dark tobaccos of southern and western Kentucky and Tennessee are heavy tobaccos, nearly related to the White Burley, but on account of their peculiar characteristics are largely exported. Grown in Kentucky, southern Ohio, Tennessee, and to a limited extent in North Carolina, and Virginia.

Orinoco and Yellow Mammoth.—Used for plug wrappers and fillers and are stemmed for export trade. Adapted to rich, well-drained soils, doing especially well on alluvial soils underlaid with red clay subsoil. The Orinoco variety has short, broad leaves, while the Yellow Mammoth has large leaves, both varieties having a rapid

Wheat Succeeding Tobacco Which Had Been Fertilized with a Mixture. Dept. of Agr.

Transplanter at Work in Tobacco Field. Dept. of Agr.

rate of growth. The Little Orinoco type has a long, narrow, tapering leaf, and is the sweetest variety grown. The Yellow Mammoth is largely exported for Swiss trade, and its culture is mainly confined to Tennessee. The Orinoco type is grown in Virginia, North Carolina, Tennessee, West Virginia, and Missouri.

Virginia Types (Blue Pryor, Sun-Cured, and White Stem.)—Adapted to sandy soil, underlaid with red or yellow clay subsoils. These types have very broad, large, fine leaves, of fine, silky texture, with rather tough fibers and usually have bright, fine colors. Some of the best grades are used for cigar wrappers and others for smoking purposes. Grown in Virginia, North Carolina, Kentucky, Tennessee, Missouri, and Indiana.

DIRECTIONS FOR CULTURE.

Sumatra Tobacco.—The location selected for the seed bed should have a slightly southern exposure in order to get the full benefit of the warm rays of the sun in the early spring. The slope should be sufficient to insure perfect drainage at all times. It is desirable that the seed bed be surrounded by board walls and covered with regular tobacco tenting cloth. The cover will protect the tender plants from the cold north winds and produce more uniform and favorable conditions, insuring early, rapid growth. The location should be permanent, abundantly fertilized every spring, and kept free from weeds and grass at all times. The soil becomes better adapted to plant-bed purposes each succeeding year if this method is followed. The most desirable soil seems to be a rich, friable sandy loam. Deep plowing or spading should be avoided in the preparation of the soil, the usual depth being 4 or 5 inches. The ground should be harrowed and stirred with hand rakes until thoroughly pulverized, and all roots, tufts, and clods of earth should be carefully removed.

After this preparation a liberal application of fertilizer rich in nitrogen and potash should be evenly distributed over the bed. A fertilizer containing 10 per cent of ammonia, 8 per cent of available phosphoric acid, and 12 per cent of soluble potash is highly recommended. Chlorin in any form must be avoided. After applying this fertilizer the bed should be thoroughly stirred again and left very smooth, in which condition it is ready for the seed. It is customary to sow the seed at the rate of about 1 tablespoonful to 100 square yards of seed bed. It is impracticable to sow this seed alone and it should be thoroughly mixed with wood ashes, corn meal, land plaster, or commercial fertilizer. In order to obtain a uniform stand of plants it is advisable to sow half of the seed lengthwise of the bed and the remainder crosswise.

The proper time for sowing the seed is from February 1 to March 1. Wherever practicable it is best to prepare the land and apply the fertilizer from one to two weeks before sowing the seed. After sowing, a light roller should be run over the bed, or some other means used to get the soil in a firm, compact condition, in which state it will retain its moisture, thus giving more favorable conditions for the germination of seed and the growth of the young plants. The necessity of properly caring for the seed bed can not be too strongly emphasized, since nothing is of more importance in obtaining a vigorous growth in the field than strong, healthy seedlings. They should be made to grow steadily and vigorously without being checked until ready for transplanting. In order to obtain this condition, strict and constant attention must be given to watering the bed, keeping down all weeds and grass, and preventing the ravages of insect pests. In some cases it is necessary to use an additional application of fertilizer in the way of a top-dressing. The necessity for this is often indicated by the plants turning yellow. The fertilizer should be essentially of the same composition as that previously used, and often gives best results when applied in a liquid form. This method of application makes it necessary to wash the fertilizer thoroughly into the soil by means of an abundant spray and thus avoid injury to the tender plants.

Whenever it is found that the plants are too thick in the bed it it advisable to thin them out by drawing an ordinary rake across the bed, allowing it to sink to a depth of from one-half to three-fourths inch. This can be done without seriously injuring the remaining plants and is, in fact, of positive benefit to them. In all cases some system should be provided for watering the plant beds during spells of dry weather. Water should be applied in the form of a light spray. During the first two weeks of plant growth it is essential that the surface soil be kept comparatively moist at all times, for at this stage a few hours of hot sun, after the soil has become dry, will be sufficient to kill most of the plants. Where irrigation is used in growing the general crop a system of overhead spray nozzles has been found to give excellent results.

As has been previously mentioned, great care must be taken to remove all weeds and grass that may appear among the young plants. In every case, before undertaking the process of weeding the bed, it is most important to water thoroughly. This will prevent any serious injury being done to the roots of the tobacco plants. One of the most injurious insects to be guarded against in the cultivation of the seed bed is a flea-beetle. The injury to the plants by this insect may be prevented by the use of a light spray of Paris green. The mixture should be made at the rate of 1 pound of Paris green and an equal quantity of quicklime to 100 gallons of water, which should be kept constantly stirred when in use. The same remedy can be applied in the case of the hornworm, where the seed bed is not inclosed or covered.

A very satisfactory fertilizer consists of 1,000 pounds of cotton-seed, 1,000 pounds of cotton-seed meal, 300 pounds of carbonate of potash, 700 pounds of fine-ground bone, and 800 pounds of lime to the acre. The cotton seed should be put on the field after it has been plowed and three weeks or one month before it is finally prepared for transplanting. Wherever it can be obtained cow-pen manure should be used broadcast at the rate of 20 to 25 loads per acre. Cow-pen manure promotes very rapid growth and often becomes the means of securing a good crop of tobacco on land badly infested with nematodes. This kind of plant food enables the plant to throw out new roots faster than the nematodes can destroy the old ones.

When produced for wrapper purposes the Sumatra variety of tobacco is usually grown under shade. The purpose of the shade is to protect the crop from insects and other dangers and by reason of reducing the light to secure a thin leaf. The effect of the shade is also shown in influencing the humidity of the atmosphere and the temperature. The plants under shade show a much more rapid growth than the outside tobacco, and the leaves are finer, very thin and elastic, and with very small veins. Such characteristics as these in wrapper tobacco are desired by manufacturers.

Where no cover crop is grown during the winter the land should be plowed frequently and kept thoroughly stirred. This destroys many of the nematodes, and in that way greatly reduces the damage due to these insects the following year. This constant cultivation also prevents, to some extent, the depredations of the thrips; it prevents the growth of grass and weeds, which serve as host plants for this insect.

The preparation of the soil for Sumatra tobacco must be thorough and complete. The soil should be thoroughly pulverized by successive plowing and harrowing, and reduced to a fine condition before transplanting. Deep plowing and subsoiling causes a retention of moisture in the soil if the season is too dry, and at the same time affords the best opportunity for proper drainage if there is an excess of rainfall during the growing season. The disk plow and disk harrow have been used very successfully in the preparation of tobacco soils, particularly where the content of clay is comparatively small.

When transplanting the young plants from the seed bed to the field, it is desirable to make a selection of the best and most vigorous plants in the seed bed. At this early stage of growth the most vigorous plants, having the largest and best-shaped leaves, can be very easily distinguished by the grower and selected for the field. The ordinary distance for Sumatra under cloth is 3 feet 3 inches apart for rows and 12 inches apart in the row. Under slat shades the distance between the plants in the row is usually increased to about 14 inches.

Before removing the young plants from the seed bed, the bed should be thoroughly watered and the plants taken out with all possible care. In setting the plants in the field care should be taken to avoid bending and doubling the roots, and the necessary application of water should not be overlooked. It is often found beneficial, just before transplanting, to water the soil where the plant is to be set, and to water again shortly after transplanting.

The cultivation of the crop should include the removal of all weeds from the field, particularly during the early stages of growth, and a thorough cultivation of the soil at frequent intervals in order to keep a loose mulch on the surface of the soil. It is usually the custom to hoe the young plants twice and to use some form of cultivator at least once a week during the remainder of the season until the plants have become too large for cultivation. In many instances it has been found desirable and practicable to cultivate the tobacco until shortly before the top leaves are taken off. In dry seasons this serves to retain the soil moisture by preventing excess evaporation due to soil capillarity.

When the plants begin to bud, all except the individual plants saved for seed purposes should be topped. No very definite rule can be given for this process, but it is the usual custom to break off the top of the plant just below the first seed sucker. The height of topping must be largely governed by the local soil and climatic conditions.

It is necessary to remove the suckers before they reach sufficient size to seriously injure or dwarf the plant or interfere in the development of the leaves. In most cases it will be found necessary to remove the suckers two or three times, and more frequently if the season is one which promotes rapid growth. If seed is to be saved on any of the plants, the flower cluster should be covered with a light and strong paper bag before any of the flowers blossom out, in order to prevent cross-fertilization. The bags should be kept in good condition and not allowed to injure the top of the plant in any way. They should remain over the flowers until a sufficient number has been fertilized to produce a good supply of seed.

The time for harvesting will depend to a considerable extent upon the season, but the ripeness of the leaves can be distinguished by the development of irregular, light yellowish colored patches over the surface and a thickening and crumpling of the body of the leaves. The leaves should be harvested before they become overripe, and it is the usual practice to pick them at three or four different periods, the lower leaves maturing first, the middle leaves next, and the top leaves last, generally allowing from six to eight days between each picking. After picking, the leaves are carried to the curing shed in baskets made for this purpose and are strung on 4-foot laths specially arranged for them at the rate of 30 to 40 leaves to the lath. The leaves are arranged back to back and face to face, and are regularly strung on the cord attached to the lath. The laths are then hung in the curing shed, where the leaves are allowed to thoroughly cure out.

When the tobacco is primed from the stalk it should not take more than three weeks to cure; when it is hung on the stalks from four to six weeks are necessary. The manipulation of the curing barn is governed entirely by the condition of the weather and the nature of the tobacco, so no fixed rules can be given. However, in a general way it can be said that the barn should be opened during the day and kept closed at night. If there are frequent showers and but little sunshine, the barn should be kept closed and small fires started, distributed throughout the building. These fires should be continued as long as it is necessary to dry out the entire barn of tobacco. Where charcoal is not available, wood which has as little odor and as little smoke as possible should be used. It is very important to dry out the barn without giving the tobacco any foreign odors.

To obtain the best results the tobacco should become moist and be fairly dried out once in every twenty-four hours.

When the midribs are thoroughly cured the leaves are ready to be taken to the packing house. To get the tobacco in condition to handle, all the ventilators should be left open for one night, opening them about 6 o'clock in the evening. Unless the night is a dry one, the tobacco will soften before morning and be in condition or "good order"; that is, it will have taken up sufficient moisture to make it soft and pliable. The barn should then be tightly closed, in order to retain the moisture, and the leaves taken from the laths and tied into hands of convenient size. The bottom, middle, and top leaves should be kept separate in the barn. After the tobacco has been taken down and packed it should be taken at once to the warehouse for fermentation.

The fermentation of the tobacco is to be done in bulk, and this sweating process must be watched with unusual care in order to prevent disaster to the crop. It is necessary to turn the bulk several times during the process of fermentation in order to keep the temperature at the desired point. The object of turning the bulk is to reverse its construction, thereby bringing the top, bottom, and outside layers into the middle of the new bulk. This plan will permit a uniform fermentation of all the tobacco in the bulk. A convenient and practical size of bulk contains from 2,000 to 3,000 pounds. The temperature of the center of the bulk should in no case be allowed to rise above 120° F., and after the temperature falls from 8 to 10 degrees the bulk should be turned. The desirable maximum temperature is 115° F. It takes usually from six to eight weeks to complete the process of fermentation. After fermentation the tobacco must be sized, sorted according to the different market grades, tied up in hands, and packed.

Connecticut Havana Tobacco.—There is a very limited amount of plant food in tobacco seed on account of the small size of the individual seed, so that the reserve material for the nourishment of the young plants is soon exhausted; consequently the tobacco seedlings are forced to prepare their own food much sooner than is the case with most other crops. For this reason it is absolutely necessary for tobacco growers to get the soil and plant food in the seed beds in the best possible condition for use by the young plants in order to aid the slow-growing young plants during the critical period of the first stages of growth. The seed beds should be located so that they will get all the benefit possible from the warm rays of the sun during the early spring days, as well as protection from the cold north and northwest winds prevalent at that time of the year. A southern slope where good drainage can be secured is preferable, and a good, rich, and friable soil is desirable for the tobacco seed beds.

As a rule 200 square feet of seed-bed space should be provided to furnish sufficient seedlings for an acre of tobacco, although if the tobacco is to be transferred at different periods a less area will be found to be sufficient. The seed beds are generally 8 feet wide and as long as is necessary to furnish sufficient seedlings for the field. They are usually laid out from east to west.

The framework of the seed bed is usually made of 2 by 12 inch boards, set in the ground from 3 to 4 inches, one side being sunk 2 inches lower than the other in order that the sash may lie over the top of it in a slanting position, so that the plants will receive all of the sunlight possible.

The best method of covering the bed is by means of glass in sash about 3 feet wide by 8 feet long. These sash are laid over the top of the framework and of course can be removed at any time when it is necessary. In some cases heavy cheese-cloth or tobacco cloth is substituted for the glass covering, but the temperature of the beds can not be regulated so well as with the glass cover, and the cloth should not be used where very early plants are desired. It is claimed by old tobacco growers, however, that the plants raised under cloth are more hardy than those raised under glass, and it is a frequent practice to grow the early plants under glass and the later seedlings under cloth.

When it is necessary to water the seed bed the sash are removed temporarily and the water is applied in the form of a fine spray. As soon as the watering is completed the sash are replaced in their original positions. If it becomes necessary to air or cool the beds one or more sash can be raised until the desired object is accomplished.

The soil for the seed bed should be a light sandy loam, as free from weed seed, fungous diseases, and insect pests as possible. It has been found that by sterilizing the soil used in the seed bed the expense of weeding the beds can be done away with. The sterilization of the seed-bed soil results in the production of better plants than are grown in soil which has not been sterilized and also destroys the fungous spores which frequently interfere with the successful raising of young plants. The upper 6 inches of the soil in the seed beds is removed and placed in an ordinary wagon box, in the bottom of which three perforated pipes are laid and attached to a steam boiler. The sterilization process requires about 40 minutes for each wagon box of soil, the time being determined by placing a potato in the soil and supplying steam until the potato is baked. A large quantity of surface soil in the seed beds can be sterilized in this manner in a comparatively short time with little expense.

A successful method of heating seed beds is by the use of fresh horse manure. In this case the beds should be dug out 2 feet deep about a week before the time for sowing the seed. The fresh manure should be packed in this space to a depth of 1½ feet and covered with 6 inches of the sterilized soil. Another successful method of heating the seed bed is by the use of hot-water or steam pipes, laid around the sides of the bed or under the surface of the soil. General experience has proved, however, that the manure beds are equal in value, if not superior, to the artificially heated ones, mainly from the fact that the heat is distributed evenly through the soil in the seed bed, while in the case of hot-water or steam pipes the surface of the bed or the air space is likely to be hot while the soil may remain cold and in poor condition for the growth of the young plants.

The soil for the seed beds should be fertilized with a highly nitrogenous fertilizer, the one most commonly used being cottonseed meal in combination with a complete fertilizer containing phosphoric acid and soluble potash. This fertilizer should be thoroughly worked into the soil.

In preparing the soil for the sowing of the seed, it should be most carefully handled, so that at the time of sowing it is in a fine, loose, and friable condition, with an even surface. As the tobacco seed is very small, it is necessary to have the soil in the finest possible tilth in order to present a uniform condition for the seed. During the growth of the young plants it is well to sprinkle over the beds a light dressing of nitrate of soda, dissolved in water, after which it should be washed into the soil with a light and fine spray of water. It is sometimes found desirable to add a light application of phosphorus, in the form of ground bone and carbonate of potash, if the soil is found to be deficient in these elements of plant food. It is the usual practice in the North to sprout half of the quantity of seed used for sowing in moist but not too wet apple-tree punk or rotted cocoanut fiber about one week before the time for sowing the bed. For this purpose the seed is thoroughly mixed with the punk and placed in a glass jar, which should be kept in a warm room. The seed will sprout quickly in this medium, and it is probable that earlier plants can be secured from such sprouted seed than from sowing the dry seed alone. The sprouted seed should be sown about the time the sprouts are one-eighth to one-fourth inch in length. Many growers sow the sprouted seed as soon as the seed coats burst and the sprouts appear. If the sprouts become too large they will be injured during the process of sowing. An equal quantity of dry seed should be mixed with the sprouted seed when the beds are ready for sowing.

It has been found by comparative tests made by the Bureau of Plant Industry that in most cases the dry seed produces plants about as early as the sprouted seed, and the plants from the dry seed are more uniform in size and apparently more hardy than those raised from the sprouted and dry seed combined. In order to get an even distribution of seed over the seed bed in sowing, it is a good plan to mix the dry seed and the sprouted seed with several times its bulk of land plaster or gypsum, or, if this is not obtainable, corn meal or ashes, so the seed can be sown more evenly over the bed. One to two tablespoonfuls of seed should be used for every 100 square yards of seed-bed surface.

After sowing the seed it is desirable to pack the surface of the bed carefully with a roller or heavy plank, in order to press the soil closely about the seed. Another good plan is to cover the seed by lightly raking the surface with an ordinary garden rake, and this method is preferred by many experienced growers. It has been found in the experiments of the Bureau of Plant Industry that the light seed is undesirable and in every case should be separated from the heavy seed and discarded. In order to make a thorough and complete separation, it is necessary to use some form of a wind-blast machine which will blow out the light seed without throwing out the heavy seed at the same time. The heavy seed produces the most vigorous and uniform young plants in the seed beds, and these plants are most desirable for use in the case of all varieties of tobacco.

The Havana seed variety of tobacco is usually sown in the seed bed from the middle of March to the middle of April, and the plants are ready for setting out from these beds from May 10 to June 10.

One of the most important points in the raising of a successful crop of tobacco is the care of the seed bed in the production of the seedlings. It is necessary to water the seed bed frequently, usually once or twice every day during the early stages of growth. If the beds are artificially heated, warm water should be used for this watering process, as cold water cools the beds and checks the growth of the young plants. The surface of the seed bed should not be allowed to become dry, as a few hours of dry surface will kill all of the young plants. The water should be supplied in the form of a light spray, in order not to disturb the seed or the young plants in the bed or to pack the soil so that in drying it will cake and injure the plants.

The temperature of the hotbeds should be carefully regulated, and in no case allowed to rise above 100° F. during the day or fall below 70° F. during the night. If it is possible to maintain an even temperature the plants will make the most rapid growth, but it is a question whether they will be as hardy as when subjected to the fluctuating temperatures corresponding to the natural changes between night and day. The beds can be cooled when necessary by raising the sash if the temperature rises, or the temperature can be raised at night by using lanterns set 5 or 6 feet apart in the seed bed and by covering the sash with heavy cloth, such as ordinary blankets, in order to retain the heat. After the young plants reach the proper size for setting out, usually from 5 to 6 weeks after sowing in the seed bed, the sash can be taken off most of the time during the day and the beds watered only when the plants begin to wilt. If the plants come up too thick in any portion of the seed bed, they should be thinned out by using an ordinary garden rake and pulling it through the thickly set plants. Sufficient plants will be removed in this way, and those which remain will not be injured by the thinning process, but will be benefited by the stirring of the surface soil. It is also necessary to keep out all weeds, carefully pulling them as soon as they appear among the tobacco plants. Before pulling the weeds, the beds should be thoroughly watered. If flea-beetles or other biting insects attack the young plants in the seed bed, the plants should be sprayed with a Paris green mixture at the rate of 1 pound of Paris green and an equal quantity of quicklime to 100 gallons of water. If fungous diseases begin to grow in any portion of the seed bed, it should be thoroughly aired by raising the sash during the day, and if this method does not check the growth of the fungus the beds should be sprayed with a solution of formalin—1 part of formalin to 2,000 parts of water. An application of lime dusted over the beds will also assist in preventing the spread of fungous diseases.

The preparation of the field for the plants should be begun in the autumn, if possible, by plowing the land 2 or 3 inches deep and sowing a cover crop, such as vetch or some other legume. These leguminous cover crops not only prevent washing and loss of fertility during the heavy rains of the fall and winter, but increase the fertility of the soil through the addition of the nitrogen in the tubercles of these plants and by reason of their extensive root development, which tends to break up and put the soil in the best possible tilth for the young plants. In the spring the land should be replowed, care being used to see that the cover crop is thoroughly plowed under, with an application of well-rotted stable manure at the rate of 12 to 15 tons to the acre.

In addition to the use of stable manure, it has been found that the following or a similar fertilizer should be used in order to secure the best results: One ton of cotton-seed meal, 200 pounds of carbonate of potash, 500 pounds of starter, and 1 barrel of lime to the acre. This commercial fertilizer should be sowed on the land after plowing and worked into the soil with a disk or by some other means of thorough stirring before the young plants are transplanted into the field. When the young plants are pulled from the seed beds the bed should be thoroughly wet down before pulling, in order that as little injury to the plants as possible may be inflicted during the process of pulling. The plants are usually set out with a tobacco setter. If possible, it is desirable to transplant after a shower or during a moist spell of weather, as the hot sun on the young plants in the fields is likely to cause considerable injury. Immediately after transplanting, the young plants should be dusted with a bran mash and Paris green mixture made by mixing thoroughly 1 pound of Paris green with 100 pounds of bran. This mixture can be applied to the plants by dusting through a perforated tin box, or in some cases a small fertilizer sower is used for this purpose.

In transplanting the young plants from the seed bed it is desirable to make a selection of the best and most vigorous plants. At this early stage of growth the differences in shape of leaf can be detected by an inspection of the seedlings. For the Havana Seed variety the plants should be set in rows 3 feet 3 inches apart, and the plants should be set 18 inches apart in the row. If the plants are set by hand great care should be used not to bend or otherwise injure the roots of the young plants, as such injury may result in a diseased condition of the plant, making it almost worthless for wrapper purposes.

In cultivating the field a shallow or surface cultivator should be used and the soil kept stirred frequently in order to conserve soil moisture, as well as to remove all weeds. It is usually found necessary to hoe the field once or twice during the early stages of growth in order to remove all of the weeds and to loosen the soil around the young plants and keep it in the best possible condition for their most favorable growth.

When the plants begin to bud all except the individual plants saved for seed purposes should be topped. No very definite rule can be given for this process, but it is the custom to break the tops off the plants just below the first seed sucker. As a rule the height of topping must be governed by local conditions, such as the soil fertility and the season. In most cases two or three of the top leaves are removed in topping. It is necessary to remove the suckers before they reach sufficient size to seriously injure or dwarf the plant or interfere with the development of the leaves. It will usually be found necessary to remove the suckers two or three times during the season in order to keep the plants free from these injurious branches.

It has been found in the tobacco-breeding investigations that by selecting seed from plants having few suckers, sucker-resistant types of tobacco can be secured, and it is recommended that in the case of all of the wrapper varieties of tobacco, particularly the Havana Seed tobacco, such a plan of seed selection be followed. In saving seed from carefully selected plants the flower clusters should be covered with a light and strong paper bag before any of the blossoms open, in order to prevent accidental cross-fertilization. These bags should be of light but strong paper, and should be kept in good condition and moved up the stalks occasionally so as not to allow the bags to injure the tops of the plants in any way. These bags should remain over the seed head until all of the flowers that are to be used for seed-saving purposes have been fertilized, after which the bags can be removed and the seed allowed to mature in the open.

The time for harvesting this variety of tobacco varies with the season, but the ripeness of the leaves can be distinguished by the development of irregular, light yellowish colored patches over the surface and a thickening of the body of the leaves. By crumpling the leaf, if the surface breaks in straight lines, or "cracks," as the old growers are accustomed to call it, the leaf is said to be in proper shape for cutting.

The plants are usually cut with a regular tobacco hatchet or knife and are strung on laths. Five or six plants are usually strung on each lath, after which they are hauled to the sheds in wagons specially prepared for this purpose. These laths are usually 4 feet in length, and are so hung in the curing shed that a space is left between each plant in order to get a circulation of air.

The curing process requires as a rule from 4 to 6 weeks. The manipulation of the barn or curing shed during this period is entirely governed by the conditions of weather and the nature of the tobacco, so that no fixed rules can be given. However, in a general way it can be said that if the barn is filled with green tobacco and the weather is hot and dry the ventilators should be open most of the time for about 3 days, by which time the tobacco should begin to yellow. The ventilators should only be closed to prevent too rapid curing during this period. The barn should then be opened at night and kept closed during the day. This is done to prevent too rapid curing, which destroys the life of the leaf and produces uneven colors in the tobacco. If there are frequent showers and but little sunshine the barn should be kept closed, and if there are indications of pole-burn or pole-sweat, small fires, at least two in every bent in the shed, should be started. In order to dry out the tobacco in as short a time as possible, these fires should be distributed throughout the shed and the tobacco above the fires protected by hoods. The best material for making these fires is probably charcoal or coke, but if these two materials can not be used soft pine wood may be found to be satisfactory. In no case should hard wood be used, as certain odors are given off which it is impossible to get out of the tobacco, and these injure the quality and the sale of the crop. To get the best results, the tobacco during the curing process should be kept fairly moist and fairly dried out once in every 24 hours.

After the curing process has been finished the tobacco is usually sorted according to grade and color as laid down by the tobacco trade. The tobacco is then arranged in hands and packed in cases, where it is allowed to go through natural fermentation, or it is placed in a room which can be heated and is there put through a forced sweat. If the natural fermentation takes place it usually does not begin until the warm weather of the succeeding summer. Great care must be used in the fermenting processes that the tobacco is not damaged by the spread of fungous diseases, mold, or other causes of injury to tobacco in cases. The cases are usually arranged to hold about 350 pounds of tobacco.

Connecticut Broadleaf Tobacco.—The methods of sowing the seed, preparation of the seed beds, and treatment of the beds are practically the same for the Connecticut Broadleaf as in the case of the Connecticut Havana variety. Many of the growers in the Connecticut Valley prefer the tent cover for the seed beds for this variety. The advantage in the cheese-cloth or light-muslin cover for the seed bed lies in the fact that plants grown under such conditions are as a rule more hardy than plants raised under glass. As the Broadleaf plants make a very rapid growth in the seed bed and field, hotbeds for the production of early seedlings are not as essential as with other slower growing varieties. To sow the seed mix one tablespoonful for every hundred square yards of seed bed with 2 quarts of ashes or meal in order to get an even sowing, and lightly rake the surface of the bed so as to barely cover the seed. If the seed is covered too deep, it will not germinate.

The seed bed should be kept moist, but not too wet, as too much water not only injures the seed, but favors the development of fungous diseases. In about two weeks after sowing, the young plants will appear, but at this time they make a very slow growth, as the plant food in the seed has been exhausted and the plants must meet new conditions. At this stage, if the surface of the bed dries out, the young plants will be killed, so that it is absolutely necessary to use the greatest possible care in watering the beds. After the young plants have developed root systems and become established for independent growth they make a very rapid growth, and it is usually desirable to apply liquid manure. If the seedlings begin to turn yellow, it is a sign that more plant food is necessary, and this can be applied in liquid form. The young plants should be set out when the leaves are about five inches long. Large plants are not desirable, as they grow spindling, while very small plants are likely to die after transplanting if any unfavorable conditions develop. In transplanting, the beds should be thoroughly watered before pulling the plants in order to avoid disturbing or injuring the roots. After pulling the plants they should be placed in a basket, roots downward, and set in a shaded, cool place until set out in the field.

The preparation of the land for planting should be thorough, and the soil should be in as good tilth as possible. Cover crops, such as vetch, are desirable for plowing under. A disk cultivator is a good implement to fine the surface soil, after which the land should be fitted with drag and harrow, in order to get the surface as level and fine as possible. The land is usually fertilized with well-rotted barnyard manure, at the rate of from 8 to 12 tons per acre, plowing it under in the spring. Frequently tobacco stems, at the rate of from 500 to 600 pounds per acre, are used as a fertilizer in the Broadleaf sections. Most crops of Broadleaf tobacco are grown on these fertilizers alone, but in recent years the growers have begun to apply about 1 ton of cotton-seed meal, 200 pounds of carbonate of potash, and from 1 to 2 barrels of lime per acre in addition to the usual tobacco starter.

The seedlings of the Broadleaf variety are usually set in rows 4 feet apart and the plants from 22 to 24 inches apart in the rows. In all cases water should be used in transplanting, even if the ground be moist. If the plants are set by hand, one person distributes the plants at the proper distance along the rows, followed by a man or boy who, with a round stick, makes a hole for the plants. A third person sets the plant in the holes and presses the soil firmly about the roots, leaving the surface of the soil as loose as possible. As the plants are set in the holes, a cupful of water should be poured into the holes, and some growers prefer to add water to the plants directly after they are set, although this practice leaves the soil about the plants in such condition as to bake, especially during a hot, dry day.

The object of the cultivation of the field is to keep the soil in as good condition as possible and to prevent the growth of weeds and the loss of soil moisture. In most cases a loose mulch should be maintained by frequent, shallow, level cultivation. As the plants grow, the soil should be stirred with a hoe around the plants. One of the best cultivators is called the Prout hoe, which is adjustable to the width of the rows, the small shovels leaving the surface with a fine even texture.

The topping process is necessary in order to direct the strength of the plant into the development of the leaves. After topping, the surface of the leaves very rapidly increases, the leaves thicken, and the ripening processes are hastened. The Broadleaf plants are usually topped below the first large sucker. If it is found desirable to hasten the ripening process, the plants are topped low, while if necessary to prevent the development of too thick leaves the plants should be topped high. Usually the topping process is delayed until most of the flower buds appear, so that the topping can all be done in one operation, but many growers prefer to remove the buds as soon as they appear, going over the field later and topping to the desired height. As soon as the suckers appear they should be broken off, and in order to do this effectively it is necessary to go over the field once a week after the plants have been topped.

The time to harvest the crop can only be determined by experience with the strain which is grown. As a rule, a ripe leaf has a rough feeling to the touch, and there is a change in the color of the leaf from a dark to a lighter green; also, by folding the leaf between the fingers a ripe leaf will break easily. In the Broadleaf variety the plants are usually cut, and as all the leaves on a plant are not ripe at one time, it is necessary to harvest the crop when the majority of the leaves are in the proper condition or about the time that the middle leaves are ripe. Overripe leaves lose their elasticity and strength, and are not suitable for cigar wrappers. The plants are speared on 4-foot laths, using a detachable iron spearhead fitted in the end of the lath, placing from 4 to 6 plants on each lath.

The Broadleaf tobacco is air cured, the process taking about six weeks. After harvesting, the plants are immediately hung in the barn, and the temperature and humidity of these sheds must be closely watched and controlled by means of the ventilators. If the leaf cures too rapidly the ventilators should be opened on moist days and nights and closed on dry days. If the curing process proceeds too slowly or the tobacco is liable to injury from pole-burn or other fungous diseases, the ventilators should be opened on dry days and closed on moist days and at night. In long-continued damp spells of weather, when the tobacco can not be dried out by opening the ventilators during the day, small fires of soft pine or charcoal should be used to drive off the excess of moisture and raise the temperature in the barns.

The Broadleaf tobacco is usually fermented in cases holding about three hundred pounds, the hands of tobacco being laid in these cases with the butts of the hands on the outside and the tips in the center. The tobacco is then pressed down under moderate pressure, the tops of the boxes screwed on, and the cases kept in a room having an even temperature.

Cuban Tobacco.—This is grown without shade when used as a filler for domestic cigars. The percentage of wrappers in this outdoor crop is not large, but when the leaves are primed the percentage of wrappers is considerably increased. The preparation and care of the seed beds and methods of cultivation are about the same as in the case of the Sumatra variety. The rows in the field are arranged about 3 feet 4 inches apart and the plants set about 14 inches apart in the row. A greater distance results in thick, heavy leaves. If the plants are set too close the leaves are too thin and lacking in body for filler purposes.

No definite rule can be laid down as to the proper number of leaves to be left on the stalk when the plants are topped. This number varies with the height of the plant and the climatic conditions during the season. From 14 to 16 leaves, however, are considered desirable during the ordinary season. The suckers begin to appear very soon after topping and should be removed every 8 or 10 days or once a week when rains are frequent.

Worms are usually very troublesome on this variety of tobacco and must be picked off and destroyed as soon as they appear, or they can be poisoned with a very light spray of Paris green mixture. The "powder gun" has come into general use and is rapidly replacing the spray pump for poisoning the hornworm and budworm. The growers who still employ the spray pump use 1 pound of Paris green and an equal quantity of quicklime to 100 gallons of water, this being sufficiently strong to kill the hornworms without injuring the leaves. If a stronger solution is used there is danger of burning the leaves, so that patches of green will appear after curing. A mixture of 1 pound of Paris green to 30 pounds of lime or land plaster is recommended for use in the powder gun.

The manner of harvesting the southern Cuban tobacco is essentially the same as that practiced with the Connecticut Havana Seed tobacco. The number of plants to the lath, however, may be increased to 8 or 10, where the growth is comparatively small.

Some growers prefer to prime the Cuban tobacco. This process is more expensive, but a thinner leaf is obtained, which makes it possible to use a certain percentage of leaves for wrapper purposes. There are no advantages in this system over the present method of cutting the plants so far as the production of a filler leaf is concerned.

Where the soil has been abundantly fertilized and the season is favorable, a profitable second crop of filler can be grown, which is commonly called a "sucker crop." A week after cutting, all the suckers should be broken off the old stump with the exception of one, which is to be allowed to remain and mature. It should be handled in exactly the same way as the original crop. The sucker crop ordinarily produces about one-half the yield of the main crop. Insects are always very much worse late in the season and become very troublesome in the sucker crop.

Zimmer Spanish and Little Dutch Tobaccos.—The preparation and care of the seed bed for these should be the same as given for Connecticut Havana tobacco. The preparation of the soil and the methods of transplanting and cultivating are the same as those given for Connecticut Havana. The plants should be set in rows 3 feet apart and the seedlings set from 15 to 20 inches apart in the rows. The plants should be topped so as leave about 16 leaves for each plant. The average yield of the Zimmer Spanish variety is about 600 pounds to the acre, while the yield of the Little Dutch variety is considerably less. The methods of harvesting, curing, and fermenting are essentially the same as those for the Connecticut Havana variety.

Maryland Smoking Tobacco.—The seed bed should be located on a dark, friable, loamy soil with a southern exposure. The plants may be easily watered if the seed bed be located near a brook. The old method of burning the seed bed has been largely abandoned, but, if used, care should be taken to burn only small timber and brush. A large quantity of ashes is detrimental to the growth of the young plants. All trees within 30 or 35 feet should be cut down and piled on the north and west sides of the seed bed for a partial protection against the cold winds.

The proper time for preparing and sowing the seed bed is from February 1 to March 30. The bed should be spaded to a depth of 4 or 5 inches, and all roots and tufts carefully removed. The soil must be thoroughly pulverized with garden hoes, hand rakes, or other suitable implements. Before the last stirring an application of a highly nitrogenous fertilizer should be evenly distributed over the bed and thoroughly incorporated into the soil. A mixture of 50 pounds of nitrate of soda, 40 pounds of fine-ground bone, and 10 pounds of carbonate of potash, applied at the rate of 30 pounds per square rod, is highly recommended.

Sow the seed at the rate of two tablespoonfuls to the square rod. It can best be uniformly distributed over the bed by mixing with wood ashes or land plaster, dividing it into two equal parts, and sowing half of it over the bed crosswise and the other half lengthwise. The sides of the bed should be from 8 to 10 inches high, and wires 3 feet apart should be stretched across it. The beds can be covered with light cheese-cloth or tobacco-bed cloth, after the seed has been sowed. The covering serves as a protection against the ravages of the flea-beetles and other insects, provided there are no open spaces around the bed. All weeds and grass should be removed. It is seldom necessary to water the plant beds, except in the case of unusually dry weather. Water at this time is very essential. It should be applied as in the northern seed beds, but less frequently, it being seldom necessary to water the beds more than twice a week.

In most cases it is advisable to replenish the plant food with a top-dressing or fertilizer of the same composition as that of the first application. This should be applied in liquid form, wherever it is possible to wash it in thoroughly; otherwise it is most important to top-dress the beds only during hot, dry days. The top-dressing should be used when the plants are from 2 to 3 inches high. Where cloth is not used for a covering, the beds must be closely guarded against the attacks of the flea-beetle. When this insect first makes its appearance the plants should be treated with Paris green at the rate of 1 pound to 30 pounds of land plaster. The cloth covering should be removed from the beds at least a week before transplanting to prevent the injurious effect of the radical change from the seed bed to the open field.

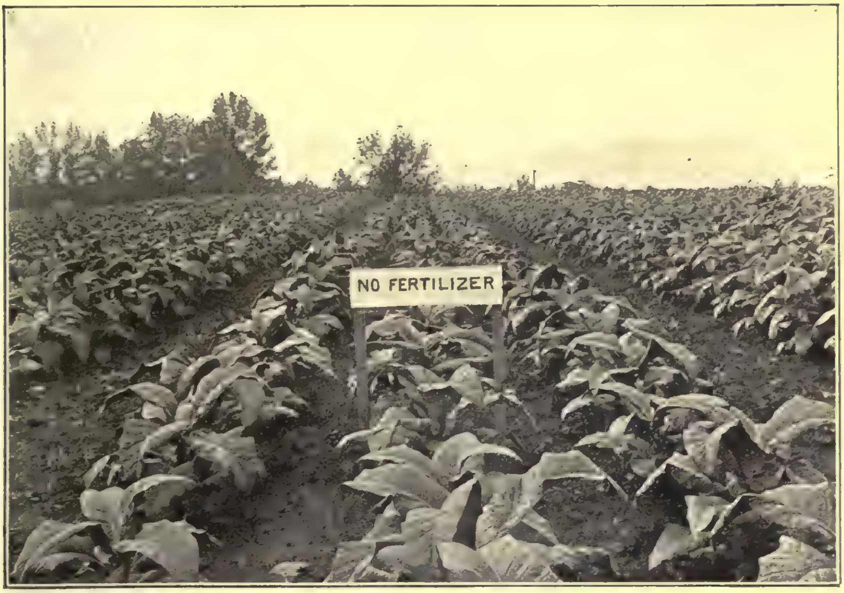
Maryland tobacco is transplanted from May 15 to June 15. Care must be used to wet the seed bed down thoroughly before drawing the plants, thus protecting the roots from injury. The mottled or mosaic tobacco, so common in Maryland tobacco fields, is frequently due to the practice of drawing the plants when the soil is not thoroughly moistened. This variety should be set in the field in rows 3½ feet apart and the plants 20 to 35 inches apart in the row.

Tobacco should be preceded by a leguminous crop of some kind, hairy vetch being highly recommended for this purpose. In addition to the nitrogen from the leguminous crop a fertilizer rich in potash and containing a moderate amount of phosphoric acid should be added before transplanting. The best stand is obtained in the field where the land has been plowed deeply and harrowed several times, thus leaving a thoroughly pulverized soil for the reception of the plants. The methods of cultivation, topping, suckering, and harvesting are essentially the same as in the case of the Connecticut Havana variety.

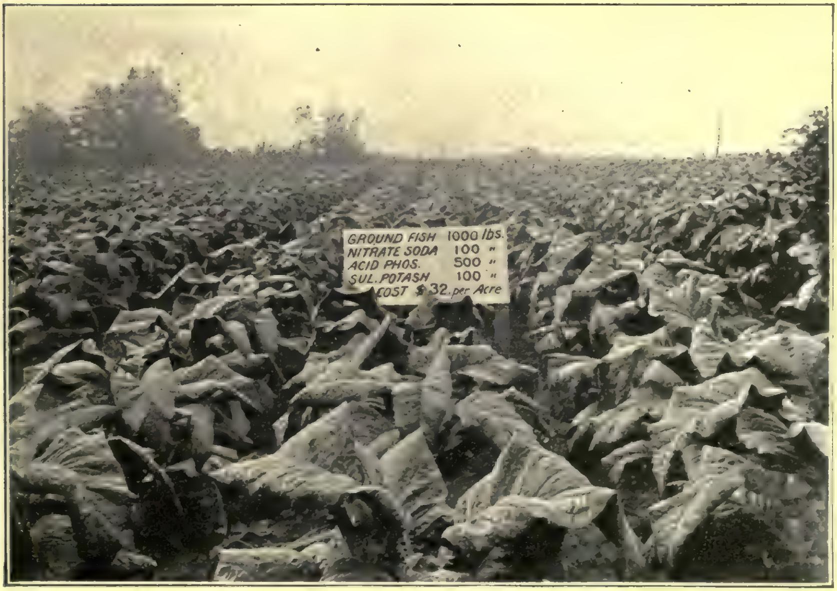
North Carolina, Tennessee, and Virginia Tobaccos.—The methods of sowing the seed and of preparing and caring for the seed bed are the same in the case of North Carolina, Tennessee, and Virginia tobaccos as those used by the Maryland growers. The seed, however, may be sown at least a month earlier than in Maryland. Two systems of harvesting are in general use, both of which have certain advantages. One of these systems is to prime the leaves as fast as they ripen and string them on laths, allowing 30 to 32 leaves to a lath. The other and more common system is to cut the entire stalk and cure the leaves on it, as is done with the Connecticut Havana variety. The North Carolina, Tennessee, and Virginia tobaccos are usually flue cured or fire cured, for which purpose a special type of barn is used. The essential points of this barn are that it be practically airtight and provided with one or two furnaces having flues leading up through the center of the barn, giving a large heating surface. There should be at least two small ventilators on or near the top of the barn.

As soon as the barn is filled with tobacco, fires should be started and the temperature raised to 90° F., where it should remain from 24 to 30 hours, during which time the tobacco becomes a uniformly bright yellow. The next step in curing is to raise the temperature from 90° to 120° F., for 15 to 20 hours. This process is commonly known as "fixing the color." Then the temperature may be increased gradually to 125° F., at which point it should be maintained for about 48 hours. By this time the leaves should be almost, if not entirely, yellow, but the stalk will still be green. In order to cure out the stalk, the temperature can be raised to 175° F., at the rate of 5 degrees an hour, where it should remain until the stalks are thoroughly dried. Great care must be taken during the entire process of curing not to allow the temperature to fall, for a lowering of the temperature during the process of curing invariably produces discolorations in some parts of the leaf.

White Burley Tobacco.—The seed bed should have a slightly southern exposure in order to get the benefit of the warm rays of the sun in the early spring, and the beds should be protected from cold winds. The best soil for the White Burley tobacco is a rich, friable, virgin loam or sandy soil. The best plan is to burn and prepare the seed bed on old sod lands. Many farmers select a spot in a vegetable garden and cover it with virgin mold taken from the



Tobacco which Received no Fertilizer. Dept. of Agr.



Tobacco Fertilized with a Mixture Proposed by Dept. of Agr.

woods, and sow it, after thoroughly burning the land until it has a reddish or brick-like appearance, when it should be spaded up and thoroughly chopped over with hoes until it is fine and even. The ashes should not be raked off, but should be thoroughly mixed in with the soil. As soon as the ground can be worked in the spring, it should be lightly spaded and thoroughly loosened to a depth of 2 or 3 inches with harrows or hand rakes. When in good condition, it should be marked off in beds about 4 or 5 feet wide and seeded. It is the usual custom with this variety to use a heaping tablespoonful of seed for every 100 square yards of seed bed. After sowing, the best plan is to run a heavy hand roller over the bed or press it with a board or with the feet. As a rule, the bed is tramped over with the feet until the surface is packed. The seed bed is usually protected by a canvas covering to prevent the ravages of flea-beetles and to keep the bed moist and warm.

The preparation of the land is generally begun in the month of March, the usual plan being to turn under the soil with a 2-horse plow to the depth of about 8 inches. About the middle of April a revolving disk or harrow is run over the land in order to cut the sod to pieces, after which the field is smoothed over with a slab drag. It is very rare for fertilizers or manure of any kind to be used in the White Burley districts. Tobacco stalks and trash from the barnyard are preferred to any other fertilizer for this tobacco. Owing to the fact that the crop is grown for two years and the field is then put in rotation with other crops, the fertility of the soil is maintained.

The tobacco plants are usually set after a shower, or when there is no rain they are set out in the afternoon. The land is cultivated with a bull-tongue cultivator during the first week or so, and then cultivated every week with a double-shovel cultivator as long as it is possible to do so without injury to the plants. As soon as the cultivation is finished the plants are topped, leaving from 16 to 20 leaves on each plant. From four to five weeks after topping, the tobacco is usually fully ripe and the plants are cut with a tobacco cutter or butcher knife. The stalks are split down the middle and strung on sticks 4 1-3 feet in length, after which they are taken to the tobacco barn and hung 12 inches apart on the tier poles. When fully cured, the tobacco is sorted, usually into six grades, and the different grades are tied into bundles of from 10 to 20 leaves and packed for the market.

Directions for Saving Seed.—In all cases where new seed is taken into a locality it should be thoroughly tested before growing on a large scale. This is especially true of all seed imported from Cuba, Sumatra, Turkey, or other foreign countries. The past few years have witnessed a striking illustration of the effect of using seed direct from tropical regions, such as Cuba and Sumatra, when grown in the northern tobacco districts. The plants grown from this freshly imported seed broke up into many different types, some of which may prove valuable, but most of the types are irregular and undesirable. Therefore it has been a common experience for growers to suffer great losses by reason of the presence of these undesirable types during every season in which the seed was used. This breaking up of type is due to the effect of the change of soil and climatic conditions, resulting in striking variation in the plants grown from the imported seed. The variation is particularly marked where southern seed is taken to northern tobacco districts.

Experiments have shown that if the seeds from typical and desirable plants in these crops are saved under bag, and thus protected from cross-fertilization, the plants produced from such seed will be uniformly like the parent plants. The second season it is a good plan to increase the area of plants grown from seed saved under bag, and from the most desirable plants in this crop selections of seed can be made for future general crops. If the crop during the second season shows uniformity of a desirable type, it is advisable to save a large quantity of seed under bag—if possible, sufficient to plant several succeeding crops—in order to provide for a possible failure of seed production in future seasons. Inasmuch as tobacco seed when properly cared for will retain its vitality for from 10 to 20 years, this seed can be safely used, if necessary, for 5 years. The best practice, however, is to save the seed for the following year's crop every season unless some accident should greatly injure the crop.

The grower of all new varieties of seed should test them on a small area before using them for his entire crop. In some cases new seed, when grown under conditions different from those under which the seed was produced, develops plants which are subject to fungous diseases or insect enemies in the new conditions. Therefore it is a wise plan to grow a small area of tobacco the first season and observe the plants carefully in respect to the presence of fungous or other diseases before using them in large fields. In other cases certain fungous diseases are present in the soil, which attack and destroy the varieties imported from other regions. In most cases resistant plants can be found in fields affected by these diseases. The structure or habit of growth of these resistant plants is such as to make them immune to these attacks. The seed of resistant plants should be saved under bag and used for the next year's planting. In this way resistant strains of tobacco which will prove to be immune to the attacks of the various diseases may be secured.

In selecting seed plants several important facts should be taken into consideration. All the plants in the field should be carefully studied and observations made on the shape of the leaf of the different plants, on the variations in size and color of leaves, and on the time of maturity of individual plants in the field.

The number of leaves and the number of suckers should be counted on many plants in the field from which seed is to be saved, in order that an accurate idea may be gained of the extent of variation in the variety as regards these points. As a rule, there is a great variation in all of the important characters which go to make up the type of plants, and individual plants will be found which have desirable shape, size, and color of leaf, which mature early and have an extra large number of leaves and few suckers. The grower should decide in his own mind on the type of plant which he desires to grow for his crop and should carefully select those plants in the field which most nearly fulfill this ideal.

The flower head on the selected seed plants should be inclosed with a light but strong paper bag just before the flowers begin to open. It is usually a good plan to remove two or three of the top leaves and suckers just below the flower head. The bag should be tied around the stem in such a way as not to interfere with the growth. It will be found that at this period of growth the plant increases in height very rapidly, and it will be necessary to raise the bag occasionally in order to prevent the flower head from pushing out through the bottom of the bag. For most varieties a 12-pound bag is the most desirable size. This bag should be of strong but light material. The ordinary paper bag found at any grocery store may be satisfactory for this purpose.

When the seed pods have turned brown, indicating maturity, the entire top of the plant should be cut off. The bag should be opened and all of the small and late pods picked off and only the large, heavy, plump, and well-developed seed pods allowed to remain. The bag should then be replaced and the seed head hung up in a dry place where there is a free circulation of air, such as the attic of a house, until the seed pods are thoroughly dried. After this the pods should be picked off from the stem and the seed shelled out. After the seed has been secured, all of the light seed, hulls, and chaff should be removed by the use of a seed separator, or by some form of air-blast machine adapted for this purpose, and only the heavy seed should be retained for planting. The heavy seed should then be placed in dry glass jars and set in a safe place. In this condition the seed will retain its vitality unimpaired for a long period.

In many cases it may be desired to cross an imported with a native variety. The object of such crosses is to secure the improved quality of the imported strains, combined with the hardiness and yielding power of the native varieties. In the case of tobacco such crosses are easily made by the grower. The tobacco plant has a perfectly self-fertile and complete flower, but is easily cross-fertilized. In order to prepare the flower for cross-fertilization, the anthers should be removed from the selected flowers shortly before they open and discharge their pollen. After an examination of a number of flowers in the field the grower can very readily observe the proper time to remove the anthers so that none of the pollen shall have escaped and fertilized the flower. One easy means of noting this time is to observe the condition of the corolla. The anthers should be removed just before the corolla opens. As soon as the anthers have been removed, a small paper bag should be tied over the flower and allowed to remain for at least one day or until the stigma becomes receptive for pollen. This receptive condition of the stigma is easily noted by the presence of a sticky, viscid substance over the surface. At the proper time for pollination, anthers from the desired imported strain which are just ready to discharge their pollen should be secured. These anthers should be broken open and the pollen carefully rubbed over the surface of the stigma of the flower to be fertilized. As soon as this pollination has been completed, the small bag should be replaced over the flower and allowed to remain there until the end of the season. A small tag should be attached to the flower, giving the name of both parents, as Havana × Sumatra (the first name referring to the female and the second to the male parent), with any other data which would assist the grower in keeping a record of the parentage of the cross.

The best plan which can be followed in the case of crosses is to grow 100 plants of each cross and carefully note the characteristics of the hybrid plants. It will be found that there will be considerable variation in the plants the first season. Seed should be saved from those plants which are most desirable and which show the greatest improvement over the native varieties. The next season a larger area can be planted from this seed; and if the crop is uniformly of the type desired, enough seed can then be selected the second season to plant the entire crop the third year.

How to Secure Good Seed.—1. Save the best plants in the field for seed plants. During the cultivation of the crop and the suckering and topping processes a constant search for good plants should be made by growers.

2. When good plants are observed, they should be plainly marked by a tag or rag tied to the plant, so that they may be easily found and to prevent them from being accidentally topped.

3. Place a light, 12-pound size, manila paper bag over the flower heads of the selected seed plants before the first flowers open. Inspect the bags every few days for the first two weeks and raise them up farther on the growing stems, arranging them so as to prevent any injury from crowding in the bag during this period of growth.

4. At the end of the season, when the seed pods are ripe, cut off the plants near the ground without removing the bags and hang them up in a dry place. The bags serve to catch the seed which may fall out of the capsules on drying.

5. After the seed has thoroughly dried, shell it out of the capsules and separate the heavy seed for use by the means described in this paper.

6. It would be well for every grower using this method of seed selection to save some seed in the ordinary way and plant it for comparison.—(B. P. I. B. 91.)

The Curing Process.—The tobacco crop should be large enough so that a unit of the curing barn can be filled with one grade of tobacco, either wrapper, binder, or filler, in the shortest possible time. This filling of the barn may be allowed to extend from two to three days, but it will be advantageous to fill the unit in a shorter time if possible. The cure depends upon the exclusion of light, thorough ventilation, and perfect control of temperatures and humidity. A condition having been produced in the leaf in the field by the topping and suckering process, by which the amount of enzyms in the plant cell are greatly increased, the object of curing is to produce a yellowing in the leaf by prolonging the death of the green cells in the leaf. The yellow color is essential. Without it the leaf cures black. If the leaf dries too rapidly, and yellowing does not occur, it cures green. The whole curing process is a delicate one, requiring constant vigilance. The control of temperatures, ventilation, and humidity are a matter of practice which will have to be determined in each locality. In general, the temperatures should remain low until the leaf has wilted and should never be allowed to go so high as to set the green color in the leaf. The temperature should exceed humidity from 10° to 15°. If the degree of humidity approaches nearer to that of the temperature, pole rot, stem rot, white vein, molds, and other maladies of the curing barn can not be kept out. In 1906 it is said that 20 per cent of the whole tobacco crop of the United States was affected from these causes. In a humid climate artificial heat in the curing barn is absolutely essential for this cause alone, even if its possession did not double the capacity of the curing plant.

As soon as the web of the leaf has passed from the yellow into the brown, the temperature should be greatly increased in order to dry out the stem and veins. The heat does not injure the leaf after the color is once set. As soon as the veins are dry, or as soon as the green coloring has disappeared in them, the leaf is cured and is ready for removal. With artificial heat the curing process may be finished in from twelve to fourteen days. Without heat it will require twenty-four to twenty-eight days. Artificial heat in the curing barn is an insurance and is a very important part of the investment. It insures even color, freedom from disease, and doubles the capacity of the establishment. The tobacco is now ready to take down, assort, and bundle for fermentation. After the unit is emptied it is ready immediately for a new filling. The tobacco will keep in the pile better than it will hanging in the barn on account of danger of molds should a period of wet weather ensue.

Sorting and Bundling.—The tobacco having been taken on the poles to the sorting room, the poles are bunched close in storage stalls of a construction similar to those in the curing barn. Before the leaf is removed from the string it should be roughly sorted into thin, medium, and thick leaves, all damaged leaves being placed with the filler leaves irrespective of thickness. If the tobacco on the pole is mainly thin leaves, the medium and thick or broken leaves should be stripped from the string, and vice versa, care being taken not to tear or break the leaf in pulling it off the pole. The thin, medium, and thick leaves should be placed in separate compartments. The pole having been culled, the string is taken off the pole and the leaves drawn off from it. As rapidly as assorted, the different grades should be bundled into hands. A hand consists of from 50 to 100 or more leaves. The stems are gathered in the palm of the hand between the thumb and forefinger, all butts being kept even. When the hand is from 2 to 3 inches in diameter, it is tied by bringing one leaf up over and twisting it around the butts, the loose end being tucked into the hand. As soon as from 1,000 to 1,500 pounds of tobacco of any one grade has been assorted, it is ready to ferment.

When taken from the curing barn to the sorting room, the tobacco should be moist. If the weather is cloudy or rainy, no artificial additional moisture will be necessary, but in a dry period, or when the humidity is low, the tobacco can be moistened by wetting down the walls and floor of the sorting room, or by turning live steam in the room, in case a steam plant has been provided. The tobacco must never be sprayed or any direct application of water made to it. A properly cured leaf absorbs moisture from the air with great rapidity and will hold from 20 to 25 per cent of moisture without detriment. This is about the amount it should contain when placed in the fermenting heap.

Fermenting.—The fermentation should follow immediately after the grading and sorting process, as the tobacco is then in the best condition. A much better fermentation can be secured immediately than after a delay of weeks or months. The tobacco is taken from the assorting room to the fermenting room. The fermenting room is provided with platforms 5 feet wide and of sufficient length to hold from 1,000 to 1,500 pounds. These platforms are raised a foot above the floor and should have a bulkhead at each end, about 5 feet high. The platforms are covered with cotton cloth, burlaps, or some other cheap material to keep the tobacco from coming in contact with the lumber of which the platforms are constructed. To build up a bulk or fermenting heap the hands are laid close in 4 or 5 rows until the bottom is completely covered, the butts overlapping the tops about a third of the length of the leaf, and subsequent tiers are added until the quantity at hand is all in the pile. A tin or copper pipe, about 2 inches in diameter, closed at one end, should be stood in the center of the pile and the tobacco built up around it. This tube should be long enough to reach above the top of the pile of tobacco, and the open end is placed up. This pipe is to be used for a thermometer, which can be lowered to a position corresponding with the bottom, middle, or top of the pile. If the tobacco is in proper case when it is placed in the pile—that is, if the leaf contains 20 to 25 per cent of moisture—a rise in temperature will begin at once. The fermenting heap when finished should be covered over with a tarpaulin or rubber blanket, excluding all air and retaining all moisture. No weight should be applied. When the building of the fermenting heap is finished the temperature of the room should be raised from 8° to 10° above the temperature of the pile until the temperature of the pile becomes equal to that of the room. The fermenting room should be heated to from 85° to 95° and should be kept at that temperature until the temperature of the pile of fermenting tobacco equals the temperature of the room. As the temperature in the fermenting pile of tobacco increases about 90°, the air temperature should be permitted to remain about 10° lower than the increasing temperature of the pile.

Wrapper, binder, and filler tobaccos require different treatment in fermenting, the best wrapper tobaccos being produced at lower temperatures than fillers. The higher the temperatures in the fermenting pile the darker the color of the finished leaf. Under no circumstances must the temperature of the fermenting tobacco be permitted to rise above 136° F. As soon as the temperature in the middle of the pile, which is the hottest, reaches 100° F., the pile should be torn down and rearranged on an adjoining platform. The bottoms, sides, and tops are placed in the center of the new pile, and the center of the first pile becomes the outsides, bottoms, and tops of the second pile. This process should be continued throughout the various rebulkings.

Indications are that the best qualities of wrapper leaf should not be allowed to go much over 100° F. If light colors are shown—that is, if the color of the leaf is desirable—fermentation may be reduced to a minimum, which will mean that the pile will have to be rebulked perhaps every twenty-four hours. An important point is to maintain a constant degree of humidity in the fermenting room. The air in the fermenting room should never be permitted to become dry, but should always show from 85° to 90° of humidity, irrespective of the temperature. In wrapper tobacco color is everything. As the piles are broken down and rebulked there is each time a slower rise in temperature, and it is a matter of judgment as to when the fermenting process should be discontinued. When the stage is reached where the temperature of the tobacco in the pile rises, remains stationary, and then begins to fall, the fermentation is finished.

Binder tobacco will stand more fermentation than wrapper. Thick wrapper will stand more fermentation than medium wrapper, and both than the thinnest or highest quality of leaf. The better the quality of the tobacco the greater care should be exercised in its manipulation. In the case of filler tobacco it is best to allow the temperature to approach the maximum limit of 136° at the second turning, the subsequent rebulkings being checked at lower temperatures. In the first stages of fermentation large quantities of ammonia are set free, and there is a considerable evolution of ammonia throughout the whole fermentation process. As soon as the fermentation is complete the tobacco is ready for the final sorting.

Sorting to Color and Preparation for Baling.—From the fermenting room the fermented tobacco is again taken, in such quantities as will not dry out, to the sorting room, which, as in the case of the one previously used, should be well lighted, ventilated, and so arranged that it can be kept moist. A good arrangement of this assorting room would be with north light along the whole side of the building. Direct sunshine or southern exposure is very detrimental. The sorting tables should be at right angles to the source of light, the sorters with their sides toward the window. This final sorting is the most important stage in the whole process of treatment of the tobacco leaf. The leaf must be graded to color, shape, thinness, and length, and requires a class of labor of the very highest skill. Wrapper tobacco of the Sumatra types is graded into seventy-two classes. There should be at least six colors of wrappers—dark, brown, light, green, specked, and broken. They should be graded to length, so that there should not be a variation of more than 2 inches in the length of leaf in any lot. Gradations of color can best be determined under north light. A final separation should also be made to thick, thin, and medium leaves. The more perfectly this final separation and assortment is made the higher will be the prices obtained for the crop. It is well to remember that *the selling price of a bale of tobacco is governed by the quality of the lowest grade in the bale,* and when finally prepared for marketing each bale must be marked to indicate what the lowest grade in the bale is, and the mark on the outside of the bale must be true.

After this final sorting has been completed the tobacco should again be made up into hands of smaller size, not to exceed from 1 inch to 1½ inches in diameter at the butts. No leaf should be placed flat in the hand whether previous to fermentation or previous to baling. It must be opened and flattened by the sorter to determine the size, color, shape, and other characteristics, but when these are determined the leaf should be drawn through the fingers to close it back to its natural condition. Great care should be exercised in forming the hand of the finally assorted tobacco, because the neatness of the bundle always adds to the attractiveness and selling price.

Baling.—The size of the tobacco bale varies according to the type of tobacco. The weight of the Sumatra tobacco bale varies from 175 to 200 pounds, the Cuban from 90 to 100 pounds. The bale of either type should be about a foot in thickness after being compressed. The other dimensions depend in some measure upon what tobacco is available, long leaves requiring bales of larger size than a smaller average leaf. Every tobacco company should adopt a standard and adhere to it.

A second fermentation takes place in the bale. It is a slower one and the temperatures do not rise very high, but it seems to be quite important in fixing character in the leaf. This second fermentation mellows the tobacco and tends to improve the aroma. The bales should be placed in the warehouse for at least six months before selling. The warehouse should be clean, dry, and cool, and no other goods stored with the tobacco. Tobacco very readily absorbs bad odors, and may be ruined by lack of cleanliness at any stage in its curing, fermenting, or warehousing. In the warehouse the bales should not be piled in tiers of more than four or five deep, and should be occasionally handled over and examined to see that moisture conditions are right. Even in the bale there is still danger of loss through too much moisture.

Every ounce of tobacco leaf is salable. There is absolutely no waste in this crop from the time when the tobacco is gathered in the field. Even moldy tobacco if baled by itself has value, and can be disposed of at prices which will pay for the handling.

Quality.—The quality of the tobacco is judged largely by the burning qualities of the leaf, the elasticity, the flavor, the quality and color of the stem, and the quality and color of the veins, the general texture and thickness of the leaf, the substance and nature of the gum in the leaf, the quality of the leaf, whether coarse, harsh, fine or silky, and toughness and behavior when handled, color of the leaf, and the breadth of leaf, and proportion of stem, and the length of leaf from point to butt.—(U. S. E. S. Far. Inst. Lect. 9.)

Capital Requirements.—Anyone undertaking the cultivation of tobacco should have all his equipment of land and buildings ready before an acre of tobacco is planted. Tobacco brooks no delay. Wrapper tobacco is of the highest price, and every effort should, therefore, tend toward producing as large a crop of wrapper and of as good a quality as the soil and climate will permit. When the necessary equipment has been prepared, the field operations may be begun. To do things the other way round is to risk the whole investment, for tobacco is not tobacco unless it is properly handled. The best Partidos, Cuban wrappers, and the plants producing Deli or other famous Sumatra types, are forced from the time the young plant makes its appearance in the seed bed. On the best Cuban plantations the plants are watered in the field every three or four days during the whole growing period. That plant which grows the most rapidly, other things being equal, will produce the best leaf, and of two plants set side by side, the one forced and the other not, that which is forced will produce the greatest percentage of wrapper leaves on the plant.

To grade the leaf and cure it requires a heavy investment of capital, but the growing of the leaf alone is an ideal occupation for a farmer of small means. It is becoming customary in Florida and other tobacco-producing sections of the United States for the larger growers, who control the curing barns and operate the fermenting and assorting establishments, to purchase the green leaves from small producers. The value of the finished product is sufficient to enable the larger tobacco grower to cultivate his small neighbor by paying good prices for the leaf. In fact, it is to their interests to do so. The greater the acreage of tobacco planted in any section, the greater will be the stock from which to select grades of the highest quality.

It is, furthermore, an advantage—even more than that, a necessity—that every tobacco-producing section should have a large permanent population from which to draw labor, and the individuals of that community should be landowners. The crop calls for a great deal of labor, and when labor is required it can not be put off. Wrapper tobacco which is allowed to become overripe will not make good wrappers and is not salable as such. Sumatra wrapper tobacco of the best lengths and light colors cost $4 per pound laid down in New York in April, 1907, whereas prime domestic filler was obtainable at from 15 to 20 cents per pound. This relative proportion between filler and wrapper almost always prevails, so that every effort must be made to force the tobacco plant to make wrapper leaves, and to so cultivate, cure, and ferment that the largest proportion of wrapper shall be of suitable colors, sizes, and texture. The rewards of the successful cultivator are greater than in almost any other agricultural crop.

On account of the fact that the enemies of the cultivated crop increase rapidly with each successive cultivation on the same land, it is highly desirable that the land should be occasionally allowed to rest. Hence, to grow an annual crop of 100 acres of tobacco the planter should own or have available, if required, from 250 to 350 acres.—(Hawaii E. S. B. 15.)

Marketing Tobacco.—For the production of a salable article much depends upon the character of the soil, and a great deal depends upon the skill in curing. Fully as much, however, depends upon the proper grading and sorting of the tobacco, and the style of package in which it is sent to the manufacturer. Too much can not be said about the necessity for very careful attention to these apparently small details. It is very important, moreover, that the planters should study the markets, the demands from foreign countries, the requirements of our own manufacturers, and aim to produce exactly what they want, and to get it to them in the way in which they can best use it, rather than to study the matter of economy.

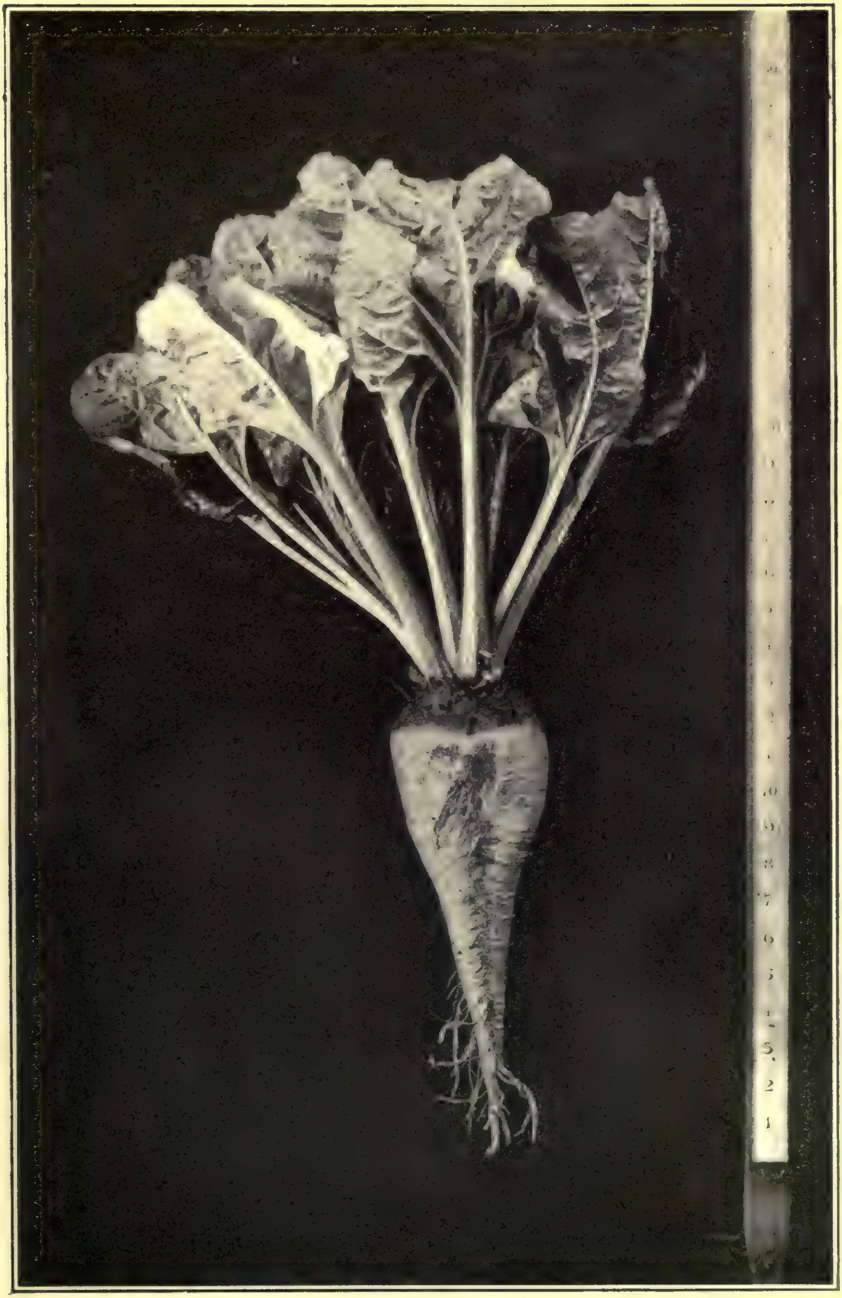
A great deal can be accomplished by improving the seed, by importing new seed, and by improving the methods of cultivation, but more can be accomplished by a steady and persistent effort to produce, through methods of cultivation and fermentation, sorting, grading, etc., the closest possible resemblance to the type which is desired by the manufacturer and the consumer. This is the business side of the transaction. A careful study of and compliance with the requirements of the market undoubtedly will insure a better price quite as much as any difference in the smoking and chewing qualities of the leaf. The excellence of tobacco in these qualities has improved much more than the practice of grading and sorting, in compliance with the market demands. There is yet plenty of room for improvement in the quality of tobacco, but just at present the chief need is for additional attention to these commercial details.—(F. B. 60.)

Tobacco is always sold on sample, and, needless to say, the quality of the tobacco in the bale must correspond to that of the sample. It is well to emphasize the point that the value of the lowest grade, quality, or size of tobacco in the bale governs the selling price of the whole bale.—(Hawaii E. S. B. 15.)

(*Additional References.*—Ky. E. S. B. 66, 129, 139; Y. B. 1905, 1908; Pa. E. S. B. 30, 72; F. B. 82, 83, 343, 416; B. P. I. B. 96, 133, 143, 212, 492; S. C. E. S. B. 86; Md. E. S. B. 67, 103; Mass. E. S. B. 47; Fla. E. S. B. 19, 30, 38; B. S. B. 27, 29, 37, 46; Wis. E. S. B. 176, 206; Conn. E. S. R. 1905 and B. 150; Tex. E. S. B. 61; N. C. E. S. B. 86; Nev. E. S. B. 20; Va. E. S. B. 166, 175; La. E. S. B. 20, 25, 33, 41; Porto Rico E. S. B. 5; O. E. S. B. 59, 161.)

THE SUGAR BEET.

The successful growing of sugar beets is an art that one acquires by practice. The farmer who has made a success of raising other crops will quite often fail at first in this one, as the methods of cultivating ordinary crops do not apply in the case of sugar beets. Certain directions for the preparation of the soil, the planting, thinning,



Healthy Sugar Beet Four Months Old.
About One-Fifth Natural Size.

and harvesting must be followed in beet culture. Although it is possible to raise sugar beets with little regard to these directions, such a crop will usually fail to pay for itself either because the yield is too small or the sugar content of the beets too low to meet factory requirements. In commercial beet growing, therefore, carelessness leads quickly to failure, while careful regard for details spells success. Success comes at first from following the advice of successful growers, and later it may be augmented by practical experience. Certain economies can be practiced, but they should never consist in planting a smaller quantity of seed than is prescribed, nor in locating the beet field on poor land.

In the manufacture of sugar from the beet, the farmer plays an important part by supplying beets in an adequate quantity and of a high quality; but beyond that he can hardly hope to enter the field. —(F. B. 52—Revision 1910.)

Varieties of Beets.—Botanically all kinds of sugar beets are of the same species as the common garden beet (*Beta vulgaris*). The difference between varieties have arisen from selection and breeding. Certain valuable peculiarities resulting from natural variations or mutations have, through careful selection, been fixed, and pure strains having these superior qualities associated with certain distinguishing external characters have been developed. The shape and size of the beet, its color, the character of the foliage, whether erect or spreading, etc., are the most frequent marks of distinction. The beets are also frequently designated by the names of those who have developed them, or by the name of the town or locality in which they have been grown.

Among the more frequently occurring varieties grown in Europe may be mentioned the Improved Kleinwanzlebener, the Kleinwanzlebener, and the Vilmorin, the two latter being most widely known in this country. Sugar manufacturers prefer those varieties which yield a high percentage of sugar, since the juices are purer and the expenses of manufacture and the cost of the raw material are less. Large beets yielding a large tonnage were usually grown in Europe prior to the adoption of legislation placing a tax on the beet itself instead of on the sugar, and were preferred on account of the value of the pulp for cattle feeding.

The certainty that the seed has been grown according to the most scientific methods is of great importance to the beet grower and sugar manufacturer, since the former may depend upon producing rich beets and receiving fair compensation for his labor and the latter is enabled to operate his factory economically. The beet has reached such a high state of perfection as to make the least degree of laxity in its treatment exceedingly dangerous to its qualities.

The best beet for general cultivation is probably the Kleinwanzlebener, which seems now to have a wider cultivation in this country than any other variety. It has a conical root, straight and even, quite large at the head and rapidly tapering, and is distinguished from the Improved Vilmorin by its brighter color and its lighter-colored leaves, which are beautifully undulating or scalloped about the edges. Coming from a cross in which the Improved Vilmorin entered largely, the Kleinwanzlebener is to-day a fixed variety and is equally well produced in France and Germany. It succeeds in soil of an alluvial nature and average richness and on level plateaus. In soils very rich in humus it ripens poorly and loses much of its richness. Like the Improved Vilmorin, toward the end of the growing season its leaves are completely spread. Under those conditions of culture where the Improved Vilmorin gives from 12 to 16 tons per acre, the Kleinwanzlebener gives from 14 to 18 tons; and from these beets 13 to 18 per cent of sugar can be obtained.

The Vilmorin is the result of thirty-five years of methodic and persevering selection based upon the lines to be indicated hereafter. In regard to its preservation, it is recognized that it holds its sugar content as well as any other variety. In those factories in Germany and France in which sugar is manufactured from the Improved Vilmorin in connection with other varieties it is the custom to reserve this variety for the end of the season and to work up the less reliable beets at an earlier date. It is also said to resist better than any other variety the unfavorable influence of certain characters of soil and of certain manures. In black soils, rich in organic matter, it gives great results, while most other varieties of beets become watery or saline in excess. Excessive quantities of nitrogenous fertilizers, which are carefully excluded from ordinary varieties, can be applied with safety to the Improved Vilmorin; a great number of experiments have shown that this can be done without serious deterioration in the quality of the beet and with a considerable increase in weight. However, experiments with Kleinwanzlebener beets show that they are also susceptible to the influence of such fertilizers, as is shown by a gain in tonnage when fertilized. From thousands of analyses it has been established that about 16 per cent of sugar can be obtained with the Vilmorin and that under favorable conditions from 12 to 16 tons per acre can be raised. In this country considerable quantities of beet seed have been grown at Fairfield, Wash., and also by the Utah-Idaho Sugar Company in Utah and Idaho chiefly, in the latter case, for its own use. In California and Michigan also some seed is produced.

Within the last six years the Department of Agriculture has been doing considerable work in endeavoring to develop a strain of beets bearing single-germ seed balls and in growing seed better adapted to the requirements of this country. Considerable progress has been made along these lines. The farmer growing beets for a factory does not have to consider these points to any great extent, as the factories buy the seed and then furnish it to their growers. It is of prime importance that the factory purchase the best seed, and they are better able to judge as to the kind of seed desired and to test its vitality.—(F. B. 52—Revision 1910.)

Moisture Conditions.—Although conditions of temperature must be taken into consideration in selecting sites for beet-sugar factories, those of rainfall must also be studied. The sugar beet requires a certain amount of moisture in order to produce its normal crop. This moisture must be derived either from precipitation in the usual way or from irrigation; or else the soil must be of that particular quality which will allow subterranean moisture to reach the rootlets of the plants. Soil of this kind appears to exist in many localities in California, where beets are grown almost without rain. The porous and sandy soils adjacent to many of the Western rivers, such as the Arkansas River in eastern Colorado and western Kansas also appear to furnish a sufficient amount of subterranean moisture to produce a good crop in connection with the rainfall, of which, however, but little is expected in those localities during the summer months. Where there is little subterranean moisture, and where irrigation is not practicable, the culture of the sugar beet should not be undertaken unless an average summer precipitation of 2 to 4 inches per month can be depended on. There are many conditions of agriculture, however, under which the beet becomes quite independent of extremes of precipitation. The beet may thrive with very little rainfall or with a great deal, if properly cultivated in a suitable soil.—(F. B. 52—Revision 1910.)

Growing Beets on Irrigated Lands.—The experience of more than twenty years in California and ten years in Colorado has shown that the climatic data, regarded as of prime importance in beet culture in Europe, can not be regarded as rigidly applicable to this country. The successful growth of sugar beets in the arid regions of our country, with irrigation, has introduced a new factor into the science of beet meteorology. While the arid area on which beets can be grown without irrigation is probably confined almost exclusively to the coast valleys of California, the successful commercial production of sugar beets in Utah and Colorado has opened a new and extensive field. What has taken place in these States is being rapidly duplicated in Idaho; a beginning has been made in Montana, and the time is undoubtedly coming when beets will be grown in Wyoming and probably throughout the whole arid region.

The northern parts of the Eastern and Middle States and the States of Oregon and Washington have at least an equal chance for the successful production of beet sugar with the fields of Germany and France. The irrigable parts of the great Southwest have advantages of soil and climate which will enable them to enter into competition in the production of beet sugar. To be able to control the moisture of the soil is a matter of prime importance to the beet grower. In the arid region the time at which the beet matures can be controlled by withholding the water. Furthermore, there is no danger of loss due to second growth, so easily induced by late warm autumnal rains.

The high cost of good irrigation renders it imperative that the areas under culture be devoted to a crop which is capable of producing a more valuable yield than is afforded by cereal culture. In a dry soil the beet can endure without damage a low temperature, which would prove quite disastrous in a wet climate. More complete maturity may be thus obtained, and a more leisurely harvest. In fact, there is no staple crop which can compete with the sugar beet in demanding the favorable attention of those interested in irrigation. If a net profit of from $10 to $20 per acre can be secured, from $100 to $200 per acre can be paid for the land. It is estimated that nearly 80,000,000 acres of land in the arid regions of the United States may eventually be irrigated, being nearly one-fifth of the total area. Of this area perhaps 10 per cent is capable of easy and speedy irrigation. One million acres planted to beets would yield, under intensive culture, a quantity of sugar sufficient, with the Louisiana product, for domestic consumption. There is nowhere in sight a more promising prospect for agricultural development than in the production of sugar beets on irrigated lands.—(F. B. 52—Revision 1910.)

The Soil.—In the selection of soil for sugar-beet production, the tonnage, the sugar content, and the purity coefficient must all be considered. If tonnage alone were desired the problem would be much simpler; but as a rule (to which there are some exceptions) unusually large beets are lower in sugar content than the smaller ones. The time may come when, by proper selection and care, the larger beets will generally contain as high as or even a higher percentage of sugar than the smaller ones do now; but, under existing conditions, it is sometimes possible to get better returns from a smaller than from a larger tonnage. For example, 12 tons per acre of 12 per cent beets at $4.50 would bring $54, whereas 10 tons of 15 per cent beets at the same price, plus an additional 33 1-3 cents for each additional 1 per cent of sugar, would bring $55, with the cost of production in favor of the smaller tonnage. This being true, that soil is best adapted to the production of sugar beets which will yield a fair tonnage with a high percentage of sugar, provided the coefficient of purity is not lowered. An ideal condition would be a large tonnage with a high sugar percentage and a high coefficient of purity.

There are several kinds of soil which, under proper conditions, will produce good sugar beets. Experience has shown that a clay loam containing a sufficient supply of humus is one of the best sugar-beet soils. Likewise a sandy loam containing a proper amount of humus is usually satisfactory. In some portions of the West and Middle West there is a soil known as adobe, which though somewhat difficult to till, gives good results when planted to sugar beets. In some of the fertile valleys of the West there is a black soil almost inexhaustible because of its great depth, which yields a fine, rich beet. As a rule, the so-called muck soils are not satisfactory for this crop, but when properly drained, fertilized, and tilled they produce a satisfactory quantity and quality of sugar beets, especially if they have a rather firm subsoil. The stony or gravelly soils and the loose sandy soils should usually be avoided in selecting sugar-beet land. However, some good crops of beets have been grown even in these unfavorable soils, though these have been exceptional cases.

Soils that are strongly alkaline are not to be recommended for sugar-beet culture, although the beet is more resistant to alkali than most farm corps; and indeed soils that are too strongly alkaline for nearly all other crops will sometimes produce a fair yield and quality of sugar beets. Undoubtedly, many of the alkaline soils of the West could be rendered suitable by proper treatment not only for sugar-beet growing but for general farming. As a rule, a virgin soil should not be used for growing sugar beets, even if it is of the kind that usually gives good results from sugar beets in rotation with other crops. The virgin prairies, however, are more likely to produce good results the first few years than are the virgin timber lands.

It should be noted also that the nature of the subsoil is an important factor in sugar-beet production. If the subsoil is too hard the beets will not penetrate it readily, and as a result will be pushed out of the ground in the process of growth. This may usually be remedied, however, by the use of the subsoil plow. The subsoil should not be impervious, as this prevents a proper drainage; on the other hand, it should not be too loose, as this allows the water to pass through too freely. While the beet is capable of withstanding extremes of moisture better than most farm crops, it is entirely possible for its growth to be checked by either too much or too little water.

Location of Land for Sugar Beets.—The location of the land on which sugar beets are to be grown should be considered from several standpoints. So far as sugar-beet growing has been tested, there are fairly well-defined limits beyond which the crop is not profitable. It is possible that the sugar beet may be so acclimated as to extend considerably its present geographical limits. However, the present satisfactory sugar-beet territory in the United States is sufficient for the production of all the sugar needed on the American continent, and will therefore accommodate the expansion of the beet-sugar industry for many years to come. Geographically, the sugar-beet territory is a somewhat wedge-shaped area, which extends from the Pacific to the Atlantic, with the broad end of the wedge toward the Pacific, comprising nearly the whole of the States of California, Oregon, and Washington. The whole area tapers irregularly toward the east, the line of the southern boundary running north of Maryland and passing into New England. South of this area the mean temperature is too high for proper sugar production, although the tonnage produced is usually satisfactory. North of the sugar-beet area the season is too short to allow the beets to ripen thoroughly; hence the sugar content is too low for profit. In addition to the temperature limits there must be, as already indicated, a sufficient supply of moisture; but it is immaterial whether the water be supplied in the form of rain or by the process of irrigation.

It is desirable that the land be located within easy reach of the factory, either by rail or by wagon road. It is usually more satisfactory to transport the beets by wagon, providing the roads are sufficiently level and firm to admit of hauling several tons at each trip and the distances are not too great. Both steam and electric cars are now used in different parts of the United States for transporting the beets to the factory. If the transportation is over one line of road only, the rates are usually not excessive; but it adds one more item to the cost of production without materially decreasing the labor, since the beets must be loaded into the wagon in the field and unloaded into the car, which is often more difficult than unloading at the factory. Unfortunately, but few of the railroads have cars suitable for handling beets. At some points where beets might otherwise be grown to advantage it is quite impossible to get suitable sidings upon which the cars may be loaded, or even to get the necessary cars for transporting the crop. These difficulties, however, are gradually disappearing, and the sugar-beet industry is making headway in improved railroad facilities and in improved highways, both of which mean much to the general farmer who has many things to transport in addition to his beets.

The particular field upon which sugar beets are to be grown should be easily accessible, so that the beets may be hauled out without any special difficulty. It should be comparatively level, especially if it is to be irrigated. Fields not sufficiently level for irrigation may often be made so, provided the soil is of adequate depth to permit of leveling the knolls without laying bare the hardpan. In the valleys where irrigation is necessary, the fertile soil is fortunately of considerable depth. Hillsides should not be planted to sugar beets, for the reason that the plants do not prevent the field from washing. An attempt to grow beets in such a location, even though the soil itself were suitable, would not only result in a failure of the crop, but would also seriously injure the field for succeeding crops. Light sandy fields should be avoided, not only because the soil is unsuited for sugar-beet production, but because the sand is likely to be blown over the young beets and smother them. A low, wet field should not be used for sugar beets until it has been properly drained. —(Y. B. 1903.)

Rotation of Crops.—The continued planting of any soil to the same crop will have the same effect on irrigated as on unirrigated land, the beet crop particularly being a heavy drain on soil fertility. Rotation, therefore, is an absolute necessity in maintaining the soil at its full productive capacity. This has been realized in all of the older beet-growing districts, and gradually a system is being evolved which will give satisfactory results. Alfalfa, the principal crop throughout the irrigated areas of the West, is the plant most used in rotation. It not only fertilizes the soil by its nitrogen-absorbing properties, but is deep-rooted and yields good returns. Methods of rotation as practiced in Idaho, Utah, and Colorado vary somewhat, but the best practice is very similar throughout and consists in the planting of beets for two or three years, depending on the fertility of the soil, followed by grain, which produces a heavy rank crop after beets, then alfalfa, or alfalfa with a nurse crop of oats. The planting of alfalfa with a grain nurse crop the first year after beets is not advocated, as the grain grows very rank and does not give the alfalfa much chance to develop, so the planting of alfalfa in the second year, with or without a nurse crop, is the best practice. The alfalfa is allowed to remain two to four years, three being the most

Fourteenth Consecutive Crop of Sugar Beets in a Field Entirely Free from Curly Top. Dept. of Agr.

Sugar Beets in West, Sugar Beet Experiments of Winnebago County, Ill., Boys.

general practice. It is then followed for one year by some cultivated crop, such as potatoes, melons, or corn, so that the weeds and alfalfa which remain may be destroyed to a large extent, and then goes back to beets for two to three years. The method of plowing up alfalfa used in Idaho is strongly recommended. This consists of dragging or railing the alfalfa when the second crop has reached the blooming stage and plowing it to a depth of 3 or 4 inches, turning the sod completely. The plowshare should be kept sharp so that all the crowns may be cut at that depth, and a good disk coulter on the plow will be necessary to prevent clogging. By turning over the alfalfa at this time the plants will be more nearly killed out by exposure of the roots to the hot sun and the leaves and stems would have an opportunity to decompose and store humus in the soil. By following this with a deep plowing in the fall the land will be in good condition for the next season's crop. Disking and irrigating, if the land becomes dry, should precede the fall plowing. Clover and timothy are used also in rotation, and along the California coast beans are largely planted before beets, the latter crop being followed by grain.

Subsoiling below the plowing for the first crop of beets in connection with the above rotation should be practiced, as it will loosen the subsoil, which becomes hard and packed from the previous crop. This is not so necessary with the following crops of beets, as the puller or beet plow answers the same purpose.—(F. B. 392.)

Fertilization.—In most American soils there is still sufficient natural fertility to produce a good crop of sugar beets; whereas in the soils of Europe, where sugar beets have been grown for years, the farmers must depend on fertilizers to insure a remunerative crop.

The principles of fertilization depend upon the fact that a soil should have returned to it all that the harvest has removed, and an unproductive soil be supplied with those elements in which it is deficient.

The soil ingredients most essential for the successful production of sugar beets are nitrogen, phosphoric acid, potash, and lime.

The following are the quantities of these constituents in 1,000 pounds of beet roots and in an equal quantity of beet leaves, as determined by numerous analyses:

Constituents	In 1,000 pounds of roots.	In 1,000 pounds of leaves.
	Pounds.	*Pounds.*
Potash	3. 3	6. 5
Phosphoric acid	0. 8	1. 3
Nitrogen	1. 6	3. 9
Total ash	7. 1	18. 1

It will be seen from the foregoing table that, for equal weights, the leaves make a heavier drain on the plant-food elements of the soil than do the roots. The disposition to be made of the leaves is therefore a matter of considerable importance. By leaving them on the land the plant-food elements which they contain will be returned to the soil. If they are removed for feeding, the need for applications of commercial fertilizers is increased. The leaves may, however, be fed and the resulting manure may be returned to the soil without material loss of these fertilizing constituents; or in some cases stock may be turned into the beet fields to feed on the tops and leaves remaining on the ground after the harvest is completed.

Most soils contain a sufficient quantity of lime, although there are some in which the supply of lime is naturally deficient; and such soils would be benefited by an application of land plaster, burned lime, phosphatic slags, or ground shells. Phosphoric acid and potash are supplied in the form of ordinary commercial fertilizers—the phosphorus as ground bone, superphosphate, or basic slag, and the potash may be supplied in the form of muriate or sulphate of potash or as kainit.

Nitrogen may be supplied in the form in which it exists in ground bone, or from the refuse of the slaughterhouses in the form of dried blood and tankage, or as cotton-seed meal or oil cake, or as nitrate of soda, sulphate of ammonia, etc.

Barnyard manure offers a ready means for fertilizing the soil, and one which every farmer can employ. By its use, humus is added to the soil as well as small percentages of potash, phosphoric acid, and nitrogen. There is a great difference of opinion as to the best time and method of applying it to beet land. In general, however, it should be applied, in a well-rotted condition, in the autumn before the ground is plowed. The quantity per acre depends, of course, on the fertility of the soil; but in any case it is not best to apply a very heavy dressing. With poor soils it is best to apply the manure for several years in succession, rather than to apply enough at once to bring it up to the required state of fertility. Too copious an application of manure is apt to produce overgrowth in the beets, which makes them ill suited to the manufacture of sugar. If the manure be applied in an unrotted condition it is apt to seriously injure the crop in case of dry weather.

As to the relation which the quantity of material returned to the soil should bear to the quantity abstracted by the beet, it may be said in general that it is desirable to return as much nitrogen, from one and a quarter to one and a half times as much potash, and two and a half times as much phosphoric acid as have been removed by the roots. Greater additions of potash and phosphoric acid have no disadvantageous effects upon the crop. But it must not be expected, on the other hand, that increasing fertilization, especially with potash, will produce proportionately increasing crops, as has been asserted by some.

As regards the use of nitrate of soda for fertilization, if applied late to the beet crop, it prevents its ripening, thereby lowering the sugar content. It is best applied early and in small quantities. Heavy applications are thought to injure the beet for manufacturing purposes.—(F. B. 52—Revision 1910.)

Preparing the Land for the Seed.—Preparing the soil properly for growing sugar beets is another important feature, and comes next to the selection of the soil itself. All the different important steps necessary in growing a beet crop must be considered. A failure in any one of them, or a lax or loose method, may result in disaster or loss. Having determined to grow the crop, no pains should be spared in doing it right. Everything depends upon doing each part thoroughly and faithfully. The preparation of the seed bed proceeds differently under different conditions of soil and climate.

There are two things, however, that apply generally: (1) Deep plowing, and (2) minute pulverization by surface harrowing. Often it is necessary to subsoil while turning the land with a stirring plow. Many instances are reported where this has not appeared beneficial, many instances where it has appeared to be actually harmful, and many more where it has been absolutely necessary. Where winter freezing obtains, fall plowing is usually preferable, if possible. In the first place it catches the summer and fall crop of weeds and grass and turns them under, thus eliminating some of the difficulties of cultivation during the growing of the plants. In the next place, fall rains or irrigation dampen the soil, and the upheaval through freezing mellows it, and makes available certain of its elements of fertility.

After the land is plowed it should be thoroughly pulverized. This may be accomplished in several ways—by harrowing, dragging, planking, and rolling. Whatever local system is used most successfully in accomplishing this purpose is the most desirable. The idea is to pulverize the soil, and this is an important matter. The sugar beet is, in its early stages, a tender plant, and, while the soil should be fine, at the same time it should be moist and in such a condition as to thoroughly compact about the beet ball, filling in the convolutions of its outer parts. This is desirable, because it enables the ball to absorb moisture, which promotes the germination of the seed. If the surface is left in a lumpy or cloddy condition, many of the seeds remain in open spaces allowing free circulation of the air, and, instead of being moistened, they are dried up and the germs are killed.

Sugar-beet growing is garden culture on a large scale. It might be stated in a general way that whatever is applicable in gardening in preparing seed beds, and in the care necessary to germinate the seeds and sustain the plants in their aftergrowth, will apply also to sugar beets. Most of the success of this plant during its growing season will depend upon the proper condition of the ground at the time of planting.—(O. of E. S. Cir. 11.)

Sugar-Beet Seed.—The proper selection of the seed is the first requisite in planting. At present most of the beet seed is imported from Germany and France. As with other commodities, there are a few standard varieties, the quality of which is well known. These standard varieties are also in the hands of responsible and established firms.

No one can tell much about the quality of seed by looking at it. A farmer can test the seed by germinating a certain number of seeds between two dampened blotters kept warm and moist. He can observe what percentage germinates. As each seed or ball has from one to five germs, there should be not less than 150 sprouts from 100 balls. If, in addition, 80 per cent of the balls sprout, the seed can be considered good from the standpoint of vitality. The best method to pursue with relation to seed is to consult the nearest reliable source of information, such as a factory or an experiment station which is making germination tests. The standard test usually applied to beet seed is the one called the Magdeburg test, which is as follows:

1. The seed should not have in dirt or refuse over 3 per cent.
2. The moisture of seed should be not to exceed 15 per cent.
3. In five days 100 balls should produce not less than 100 sprouts.
4. In seven days 100 balls should produce not less than 125 sprouts.
5. In fourteen days 100 balls should produce not less than 150 sprouts.
6. In fourteen days 1 pound of seed should produce not less than 31,818 sprouts.
7. In fourteen days not less than 80 per cent of the balls should sprout.

To a close observer in the beet fields the vitality of the seed as shown by germination is an important factor. It is the first evidence of the probable yield of the crop that the grower looks for. Much depends upon the stand. It is desired that a beet shall fill every place in the row provided for it. It is evident that if every third beet is missing there will only be two-thirds of the plants matured at the harvest. If the rows are 18 inches apart and the beets stand 8 inches apart in the row there will be 312 beets to the row and 138 2-3 rows to the acre. If every beet is in its place there will be 43,264 beets to the acre. If these beets average 1 pound there will be 43,264 pounds to the acre, equal to 21.63 tons. If the beets average 2 pounds, which is more nearly the usual size, there will be 43.26 tons per acre. This shows the highest possibility of tonnage per acre when all conditions are favorable and there is a perfect stand. Vitality of seed is a strong factor in reaching this ideal.

The plants should start out strong, vigorous, and healthful. They must send down their taproots vigorously and send out their laterals quickly; this enables them to entrench themselves early in the soil. Plants are like animals—vigor in youth promises much for healthful maturity. Strong vitality or germinating power of the seed indicates this early vigor which will enable the plants to withstand diseases, pests, and drought. The number of sprouting germs in a given number of beet balls and the vigor and rapidity of germination are the tests of this vitality. Home-grown seed indicate a germinating power in a shorter time of 25 to 100 per cent more than those selected from ordinary imported seed.—(Mes. of Pres. on B-S. Indus. 1903.)

Planting and Germination.—The soil being in just the right condition and containing sufficient moisture to germinate the plant, the seed should be sown with a beet seeder in rows which are 16 to 20 inches apart, the distance depending on local circumstances and kinds of soil. It is better to use a specially designed beet seeder which is adjustable as regards width of rows and the amount of seed used per acre. The amount of seed usually required is 15 to 20 pounds per acre. The seeds are sown quite thick, the regulation of the amount per acre being governed by the proximity of the seeds in the row.

It is usually anticipated that many more seeds will germinate and come up than are required. This is the insurance part of the performance. A stand of beets is absolutely essential to the success of the crop. The beet seeder can be adjusted so as to plant seeds from a half inch to an inch and a half in depth, according to the kind of soil and its condition as regards moisture, warmth, etc. Care should be taken not to plant too deep. Until experience shall have given him a definite idea of his own, the grower should seek advice regarding the proper depth from some person better posted than himself as to planting sugar beets in his locality.

Some method of compacting the soil around the seed is generally desirable. This is usually accomplished by rolling. The smooth surface left by a roller is objectionable in some localities; for instance, where the soil is sandy and there is much wind, thus drifting the sand against the young beets, cutting them off or injuring them. Under such circumstances the ground is usually "planked." This is accomplished by drawing a platform arrangement made of planks over the soil, which leaves the surface considerably rougher than does the roller. Care must be used to plant at the right time, the same as with any other crop. This must be determined by the moisture in the soil, its temperature, and the weather.

In from seven to ten days, if the soil is warm and moist enough, the beets will begin to make their appearance. The real struggle on the part of the grower for a crop begins at this juncture. There are several kinds of emergencies that may arise at this tender stage of the plant; a frost or a hailstorm can do them considerable damage, and they may have to be replanted. In replanting, it is not good practice to undertake to reset beets extensively.

This germinating period is the anxious time of the beet grower. A beating rain may crust the surface to such an extent that the beets can not penetrate it. In such cases valuable results may be produced by using a harrow to break up the crust of the surface. At every stage of the crop the beets must be kept clean and cultivation must begin at the earliest possible moment. Sometimes they are cultivated soon after planting. These first cultivations are accomplished with special beet cultivators, which work several rows at a time. These cultivators are adjustable to the width of the rows, and usually have, for the first cultivation, small, loose, sharp knives running parallel with the surface, and designed to cut off the grass and weeds just below the surface.

Bunching and Thinning.—About the time that the beets show the fourth leaf the bunching and thinning process begins. This is necessary to remove the excess of plants. Single plants should be left in the row from 6 to 10 inches apart, depending on the distance between the rows and the kind of soil. The time of thinning is important. If the proper amount of seed has been used there will be a considerable excess of plants, due to the nearness of the seeds to one another. A still further excess results from the fact that each particular seed contains from 1 to 6 germs, all of which are liable to germinate.

It is quite evident that, if all the germs in a single seed grow, there is liable to be a bunch of several plants, standing very close together, often intertwining and forming a network of rootlets. The longer these plants are allowed to grow in this way the more complex, difficult, and harmful becomes the process of removing the superfluous plants. If this thinning is put off too long it disturbs the position of the plants which are to remain, breaks their tender rootlets, and materially and permanently injures them. Every effort should be made to accomplish this thinning as quickly as possible. A little money spent at this stage proves a very valuable investment in the after stages of the plant. A beet grower should prepare himself beforehand, and be ready to accomplish this work quickly and not allow it to drag along. With the best of intentions and preparations, he is liable to be more or less hampered by rains and other difficulties, but he should not fail to exert his best efforts to get his crop thinned as soon as possible after sufficiently matured for this purpose.

The process is known in the common parlance of the grower as "blocking and thinning." Blocking is accomplished by a person walking along the row with a short-handled hoe, sharp and of sufficient width, cutting out part of the beets so as to leave bunches the proper distance apart foı the plants in the row. Thinning is accomplished by a person creeping along on his hands and knees, and with a deft movement of the hands and fingers removing all the plants in the bunch except the one his eye selects as the strongest plant. This all requires agility, attention, and industrious and laborious effort; it is in a sense a kind of cultivation, because all the soil is loosened around the plant, and should be compressed around it again with the hand before going on. Grass or weeds growing around the plants should also be removed.—(O. of E. S. Cir. 11.)

Cultivation.—The methods of cultivation are various. The object sought is the elimination of the grass and weeds, the conservation of moisture, and the loosening of the soil around the plants. Beets must be kept clean. By this term in sugar-beet growing is meant more than in corn growing. It is desired that these beets shall be rich in sugar. The sun and air are the great reagents which accomplish this result in the beets. Weeds and grass must be eliminated from the crop in order that this may be accomplished. Beets are a vigorous crop, and they should have the full sustaining power of the soil, and not divide it with waste plants and weeds.

There is a wide difference between the methods of beet culture employed in Germany and those employed in this country, and the difference is not in our favor. In Germany a plan is outlined for rotation which involves the manipulation of the land for a series of years. This land is handled in such a way as to bring about the best results during the different years in the cycle of rotation and for the different cycles planned. There cultivation and preparation of beet fields are more like careful gardening. It is granted that this involves some expense. The increased yield, however, and the economy of soil manipulation induced by its better mechanical condition, very much overbalance the expense.

The cultivation of a beet crop should begin the moment the soil is broken up for planting to beets. If the land is broken in the fall, it should be harrowed immediately, possibly rolled. It should be allowed to rest for a while, giving the weed seed time to germinate and come up; then it should be cultivated and harrowed again. In the spring after stirring it should be cultivated and harrowed several times until ready for planting. After planting, it should be gone over with a weeder or harrow as soon as the weeds and grass begin to appear. These harrowings, etc., kill weeds, conserve the moisture, and prevent the soil from baking. A cultivator should be brought into requisition at the earliest possible moment, and the services of the weeder or harrow continued alternately with the cultivator even after the plants are up. Cultivation should be continuous from the moment the beets come in sight until they become so large that it is impossible to continue. After the first cultivation the horizontal blades of the cultivator are replaced with elliptical blades, which penetrate the soil 3 to 4 inches and loosen it, making a dust mulch which conserves the moisture in the soil and promotes the growth of the plant. The cultivator is usually drawn by a single horse or mule, and is manipulated by a single laborer, who usually cultivates two or four rows at a time.

It can be seen that this part of the work is not particularly laborious. One man and one horse can cultivate many acres of beets in the course of the season. The number of cultivations given a crop varies according to the exigencies of the case. If it is a dry season, cultivation should be continuous in order to maintain a dust mulch and conserve the moisture. If the beets are excessively weedy, hand hoes should be used. The number of times the beets should be hoed also varies. The crop should be kept absolutely free of weeds; the ground should be kept soft and in good condition. If the land has become foul, the more hoeing the better the results. If the land is fairly clean, but little hoeing will be necessary.

To the average American farmer, accustomed to growing 160 acres of small grain in addition to a large acreage of corn, such an outline of work as this may seem preposterous. But it is the most logical method conceivable. This assertion will be indorsed by many successful beet growers of this country who are accustomed to beet growing in this or a similar manner. The logic of this method is that the yield and superior quality of the beets will pay all this expense and greatly enhance the profits besides. It must be within the experience of every observing farmer that a good stand of any crop is the first requisite of profit at the harvest. Such a stand depends largely upon a proper preparation of the seed bed. It must be just as patent to him that cultivation with a harrow and cultivator is a great deal cheaper than cultivation with the hoe or by any hand method. It is much easier and cheaper to destroy weeds when they first germinate, or while they are young, than it is after they have become well established in the soil. It is less expensive to cultivate in the manner above described than in the one ordinarily used, which involves hoeing and hand weeding.

To the person accustomed to his 160 acres, this method of cultivation may seem impossible, but he should not plant 160 acres in sugar beets unless he has a large capital and plenty of labor at hand. For an ordinary farmer 10 acres is considerable. For an extensive farmer 25 acres is a large tract of beets. There are farmers who can successfully grow much more. The acreage should be such that it can be gone over many times with the roller, harrow, and cultivator. If proper attention is given at the right time and is continuous, weeds can be kept in subjection with very little use of the hoe or hand work. Cultivation of other crops should teach this. Good judgment and carefully matured plans for the accomplishment of things in the right way in the proper time is of vital importance. When such judgment and such planning are contributed, beet growing resolves itself into a task comparatively easy of execution. If the farmer will use these methods and thin his beets at the proper time before they have become too large, there can be no question of a good yield.

When the leaves of the beets touch those of the adjoining rows their shade becomes so dense that the ground ceases to dry out so quickly and the weeds and grasses are overcome and smothered in the race for existence. Too much insistence can not be made on horse cultivation. Often growers stop cultivation at the critical time for its use, claiming the soil is too dry for cultivation. This is the time when it is most necessary. In fact, cultivation should be constant. Killing weeds is not the only object; conservation of moisture is paramount when the season is dry. Cultivators stir the surface much deeper and more regularly than hoeing. Constant cultivation maintains a dust mulch, breaks up and covers the sources of egress of the moisture, thus holding it in the soil for the plants. Hand hoeing in its place is desirable, but, in this country, much of it is unwise and tends to a high cost of production. A proper system of horse cultivation will lead to better results, and at a lower cost. No hand hoeing can ever take the place of the cultivator in conserving moisture.

A proper system of cultivation should greatly cheapen the cost of production of beets and greatly increase the tonnage per acre. In fact, this has been demonstrated often on the farms of successful growers. It is undoubtedly true that to unwise and expensive cultivation is due most of the discouragement in sugar-beet growing wherever it exists. It can be stated as a general rule that the best yields are not accomplished with the highest cost of production. It is common to see yields averaging 15 to 18 tons per acre in fields alongside of which are others yielding only 5 or 6 tons, the beets being grown from the same seed, on the same land, but by a different farmer.

Good judgment is also required in selecting the proper time for planting, when the soil is moist enough and warm enough to thoroughly germinate the seed. Information and advice on all of these points can be obtained from the agricultural superintendents of the sugar factories. The farmer should not follow his own judgment, and then hold the sugar factory responsible for poor results afterwards. His own judgment will be a good guide for him after he has had considerable experience in growing the beets, the same as with other crops. It will then be worth as much to him as anybody else's experience, if not more, because he will understand better the action of his soil with beets after its manipulation for a series of years. Until such a time arrives, he is bound to follow the advice of those especially provided by the factory for that purpose. In fact, as a rule, he should always secure the benefit of the advice and judgment of these factory experts.—(O. of E. S. Cir. 11.)

Harvesting.—After the crops have matured, the next work of the grower is the harvesting. The time to harvest is usually indicated by the agriculturist of the sugar factory for which the beets are destined, and notice is given to the grower to deliver his beets to the factory. An expert in sugar-beet growing can easily discern when beets are ripe. The leaves droop and take on a yellow cast. The sooner they are harvested after this the better, as they have reached their maximum of sugar content and purity. Warm fall rains are liable to start a new growth of the beets, causing them to send out a fresh supply of rootlets. This has a tendency to lower the purity and sugar content of the beets. If it is apparent that the crop can not be received at the factory at some time in the near future, the beets should be harvested and siloed. The contract usually provides for following the orders of the factory in this respect, and this is the safest course.

Siloing is performed by taking the beets after they are harvested and placing them in piles, covering them with dirt to prevent evaporation and freezing, and increasing the dirt covering as the weather grows colder. There are many methods of siloing in use. The usual one consists in piling the beets in long ricks, pyramidal in shape, with a base of about 6 feet and a height of about 4½ feet. If straw, beet leaves, old hay, or anything of the kind is used, it should be placed on the rick after the dirt. If it is placed on the beets before the dirt, it is liable, by the pressure of the dirt, to adhere to the beets. When they reach the factory this litter interferes with the further manipulation of the beets; it clogs the ditches, and some of it still adheres to the beets after they are washed and interferes with the slicing. For several reasons it is undesirable to place straw, beet leaves, or the like on the beets first.

There are many kinds of harvesters in use. A very common kind is a long-shanked plow, similar to the stirring plow, with a long slender share which cuts off the beets about 9 or 10 inches below the surface, the moldboard throwing them over on their side, after which they are picked up. Another very common variety of harvester is an implement in the shape of a plow. Instead of a moldboard it has two shanks, each terminating with a prong like a finger. These are forced through the soil, one on each side of the row of beets at a depth of about 9 or 10 inches. The opening between the two fingers gradually lessens as the beets pass through the space between them until finally the taproots are broken and the beets are lifted 2 or 3 inches from their position in the soil, whence they are easily extracted by a person following the plow.

Topping is a feature of harvesting which consists in removing the crown and leaves of the beet by a single stroke of a knife in the hands of the operator. It is the purpose of this operator to cleave the beet at the sun line, indicated by the discoloring of that part of the beet just above the surface of the soil. After the beets are topped they are thrown into piles or in wagons, or are sacked preparatory to their delivery to the factory.—(O. of E. S. Cir. 11.)

Delivering Beets to the Factory.—After they are harvested and thrown in piles in the field the beets are usually loaded into wagons and hauled directly to the factory or to a railway station for shipment to the factory. Ordinary farm wagons are often used for this purpose; but wagons especially designed for this work are more satisfactory, and hence are widely used. The bottom and sides of the wagon bed are made of slats with one-half to 1 inch spaces between. As the beets are hauled the shaking and rubbing of the beets tends to free them of adhering soil, which falls out through the cracks. The ends of the wagon bed are stationary and the sides are hinged so as to drop down. These wagons will hold from 3 to 6 tons. A net of rope having from 2 to 3 inch mesh is spread in the wagon first, and on this the beets are thrown. On arrival at the factory the side next the bin is lowered and the projecting net on the other side is fastened to a tackle and raised by power. In this way the load is dumped quickly and with little labor. Sometimes nets are used as a means of lifting beets from ordinary farm wagons.

Where the beets are shipped by rail a special dumping apparatus is installed at the shipping point. The usual form of railroad dump is a high platform approached by a long incline. The loaded wagon is drawn up, the team is unhitched, the wagon locked on the platform, the side dropped, and the platform tipped by machinery. In this way the load is dumped. With another style of dump the wagon is not driven up on a platform, but is left on the ground, the wagon bed being lifted to a height and then dumped.

In cases where there is no railroad dump, a car is placed on a siding and the beets are shoveled into it.

When delivering to the factory, the farmer need not go home with an empty wagon; he can collect manure to be used in fertilizing his fields or can obtain a load of pulp for feed. Most factories, in their contracts with farmers, stipulate that a certain percentage of the weight of the beets delivered can be taken back in the form of pulp. This is a valuable cattle food and the farmer should not miss the opportunity to use it.

Taring.—In shoveling the beets into wagons for delivery to the factory, a certain amount of extraneous matter, such as stems, tops, and clods of dirt, are also thrown in; moreover, certain soils cling to the beets more than others, especially after wet weather. Some deduction must be made from the weight of the load deliverd to account for this. Again, the topping may be very poor, not enough being removed, so that there is a loss to the factory; which should be considered. A sample is taken when the load is dumped into the bins at the factory, the actual percentage of tare is determined, and this figure is applied to the whole load. From the nature of the case, different loads may have a varying percentage of tare, and this point is a constant source of friction between the growers of beets and the factory. But usually it is stipulated in the contract made by the factory with the farmers that the latter may appoint a man to oversee this step in the process.

Siloing Sugar Beets.—When beets are to be preserved for manufacture during the winter months or for the production of seed, they must be carefully protected from the deteriorating effect of freezing and thawing. The simplest and the easiest method is to place them in piles and cover them with earth, not too deeply, for if they become too warm in the silo they rapidly lose in sugar content. When first siloed, they should be covered with only a slight layer of earth; as the cold of winter becomes more intense this covering can be increased. In some localities only a slight covering of straw is necessary to protect the beets, as, for instance, in California. In other localities, such as in Michigan and Wisconsin, it is probable that the beets have to be covered to the depth of 6 inches, and even more, to protect them from frost.

It is most important not to put too many beets in one pile, certainly not over 5 tons. If, however, the silo is made in the form of a rick, no such limitation is necessary. There must be an opening in the top to allow ventilation. In case of a rick there may be several. The silo should be placed on the highest point of land available to provide for proper drainage in case of heavy rains or melting snow. The beets should be siloed on the same day that they are removed from the ground.

The object of siloing, in case of beets for seed, is to prevent them from freezing, and greater care should be used in making the silos. In the case of factory beets, the purpose of siloing is not entirely to prevent freezing, for in the frozen state the beets do not deteriorate to any extent; but it is to keep them fresh and prevent their withering or drying out. Freezing and thawing, however, must be avoided, as beets that freeze and thaw a number of times lose a greater part of their sugar by inversion and decomposition.

It is becoming customary in this country for the sugar companies to ask the farmers to silo part of their beets when the total crop can not be worked up before winter sets in. To repay the farmer for this extra handling they are given a sum varying from 20 cents to 50 cents a ton extra. A few factories situated in the cooler regions where siloing must be practiced agree to take all of the beets of the farmer before frost comes and silo them, but this is not the general practice.—(F. B. 52—Revision 1910.)

Valuation of Beets at the Factory.—In the purchase of beets for sugar making the factories offer the growers either a "flat rate" or a "sliding scale." In case the former system is adopted, the factory offers a uniform price of $4.50 or $5 per ton for all beets which reach or exceed a certain minimum standard of quality, as, for instance, a sugar content of 12 or 14 per cent with a purity of 80. In case beets which fall below this standard are offered, the factory may make a reduction in the price or refuse the beets, but no extra price is paid for beets which exceed the standard requirements. If the "sliding scale" is adopted, the factory offers a minimum price of say $4 or $4.25 for beets which reach a minimum standard of quality, as, for instance, 12 per cent of sugar with a purity of 80, and makes an extra allowance per ton of 25 to 35 per cent for each per cent of sugar in excess of the established minimum. Under this system beets of extra fine quality may bring $5.50 per ton or even more. Some factories buy all their beets at a flat rate, others buy only according to a sliding scale, while many offer the farmers their choice between the two systems.

In determining the quality of the beets a sample is taken from each load delivered. The percentage of sugar is determined either directly from the beet or from the expressed juice. If from the juice (which is the usual method), the percentage of sugar in the beet is calculated from that in the juice.—(F. B. 52—Revision 1910.)

LABOR.

One of the most serious problems that confront the farmer to-day is the question of labor, and this is especially true of the sugar-beet grower, since he requires more than the usual amount of help in caring for his beet crop. The scarcity of farm labor is general throughout the sugar-beet area. This condition has kept the acreage down in many localities, causing the farmer to plant only the small area that he, with the help of his family, is able to care for. In a few localities the sugar companies have undertaken to supply the growers with the necessary help. This method has in general proved satisfactory, and will undoubtedly be more commonly adopted in the future, since the sugar companies are in better position than the individual farmers to secure labor and to distribute it properly.

Another serious question in this connection is the basis upon which the laborer should be employed. The common methods are by the day, the month, the season, the field, the acre, the row, and the ton. The cost of day labor has advanced from 25 to 50 per cent in some of the sugar-beet sections during the past few years. The same is probably true of the labor employed by the month or by the season. By employing labor on the time basis one can usually get the work done satisfactorily, if not so rapidly as desired. By using the field, acre, or row method the work is usually pushed more rapidly, but is not always done satisfactorily. The laborer has no special interest in the final result, and it matters little to him whether or not the stand is good or the beets make proper progress in development. The method of payment by the ton has some advantages in this regard, since it gives the laborer an interest in the highest possible yield.

The scarcity of farm labor and the difficulties that sometimes arise in having the work satisfactorily performed make it necessary, in the interest of the grower and of the industry in general, that means be devised to reduce the labor in sugar-beet production. This end may be reached either by the invention of machinery that will lessen hand labor or by producing those conditions that will render certain parts of the labor unnecessary, as for instance by the production of a single-germ seed ball, the destruction of weeds, and the more thorough preparation of the soil.—(Y. B. 1903.)

Crop Returns and Rent and Land Values.—In this subject lies the essence of the farmers' interest in the beet-sugar industry. What are the returns and what are the permanent benefits? In the beginning, it should be stated that farmers, like every other class, are divided into good, bad, and indifferent. A good farmer may make a great success in growing a crop of sugar beets, while a poor one with equal opportunities will make a failure.

There is no crop that responds so readily to good treatment as sugar beets or as surely resents bad treatment. Even when beets are given the best attention it sometimes happens that bad climatic conditions at critical times, such as drought, hail, freezing, diseases, or insect pests, may reduce the crop generally throughout the district to a small yield, say from 5 to 7 tons. Such things are providential, and are beyond the farmers' control. On account of the higher cost of production it is more unfortunate, perhaps, when the sugar-beet crop is thus affected than it is with most other crops. In sugar beet growing the profits are dependent on three things: (1) The farmer must have a sugar factory for a market; (2) he must have proper conditions for growing sugar beets; and (3) he must be a good farmer.

With a good farmer the yield will range easily from 10 to 28 tons per acre, and from that to a possible 40 tons. Ten tons per acre will yield a fair profit; 12 tons a fine profit. The profit on a yield above 15 tons per acre simply makes this crop out of comparison with any other field crop. Often a farmer receives in a season sufficient profit per acre above expenses, including a remuneration for his own work in growing the crop, to pay for the land.

A comparison of the estimated results of growing sugar beets with those of growing grain is offered, using as factors per acre the ordinary expense attending the production of sugar beets and the minimum tonnage which should result from good farming. As factors in growing the grain the ordinary accomplishments of a good farmer will be used limiting him to an amount of land such as he can ordinarily handle by his own efforts. In the end the net profits of sugar beets with the gross profits of grain will be compared.

The beets are supposed to be delivered at the market and the money for the crop to be in hand. The grain is supposed to be ready for the market. Sixty acres of land will be selected with the supposition that forty of this is planted in corn and twenty in oats. This is taken to be about what is generally attempted by the farmer who has besides to look after truck patches and garden in his stock and dairy interests. The forty acres will produce forty bushels of corn per acre; the twenty acres of oats will produce thirty-five bushels per acre; the corn is marketed for forty cents per bushel and the oats for thirty-three and one-third cents per bushel. The gross returns will be as follows:

40 acres of corn, 40 bushels per acre, 1,600 bushels, at 40 cents per bushel	$640.00
20 acres of oats, 35 bushels per acre, 700 bushels, at 33 1-3 cents per bushel	233.00
Total proceeds	$873.00

This represents the value of the farmer's time in growing the crops, the rent of the land, the cost of harvesting, the cost of seed, etc. The net proceeds will not be estimated. The farmer can judge by his own experience what part of the gross returns may be counted as net proceeds.

Turning now to the other side of the comparison:

60 acres of sugar beets, 10 tons per acre, 600 tons, at $5	$3,000
Cost of growing the beets, at $30 per acre	1,800
Net returns	$1,200

Comparing results it is found that sixty acres of sugar beets have produced in net profits nearly fifty per cent more than the gross returns in the other case. It must not be assumed that one man can grow sixty acres of sugar beets. It will require nine other men to assist this farmer in accomplishing this work with beets, but these men and a compensation for the use of capital employed in paying for labor, as well as for the time of the farmer himself, are paid out of the estimated cost of production of the beets.

By-Products and Their Uses.—The most effective sources of improvements of the beet-sugar industry is the utilization of the by-products, not only those of known value, but those to be developed. The utilization of the pulp alone, when it shall have become a staple article of animal food everywhere, will materially increase its market value and decrease the cost of the production of sugar.

Beet Pulp.—There is not an herbivorous animal on the farm that will not readily eat pulp if given an opportunity; there is not one will not be greatly benefited by it. It is good for horses, cattle, and sheep, and it is especially desirable for brood animals and dairy cows. It is a food that can be easily stored and kept, and instead of deteriorating it actually improves with age. It can be kept for several years if necessary. This is not usually necessary, but the fact is mentioned to demonstrate its lasting qualities.

Its hygienic effects appeal for it as much as its nutritive value. It is especially desirable in a food ration made up largely of grains and dry forage. If received directly from the factory, it is moist; if it is served in the dry state, it must be moistened like bran before it is used. The universal verdict of those long experienced in the use of pulp is that its sanitary qualities are very beneficial. It is not only nutritious in itself, but it stimulates digestion and makes the nutritive elements of other foods more available. It is a common observation of those feeding pulp in a ration with grain that there is a more nearly complete digestion of all; the animal is more vigorous and healthful and more susceptible to improvement from what he eats. It is not suggested here that pulp should be fed alone, any more than any other article of feed. The animal should be furnished a sufficiency of the different elements of food to uniformly build up his physical structure and supply his various needs. The thing desired is a balanced ration. Fresh pulp is a succulent food, and is a mechanical agent in the progress of digestion. The amount that should be fed depends largely upon the purpose of the feeder, whether for growth, maternity, fattening, milk producing, or simply for sustenance.

The amount of pulp entering into a ration is largely one of experiment. Usually it is necessary in beginning the feeding of pulp to graduate the amount on a sliding scale. If it is desired to fatten, the amount should be gradually increased until near the close of the feeding period, when the amount should be gradually reduced. The gradual increase is necessary to adapt the animal system to this new food and the gradual decrease to harden its flesh and secure the best qualities of carcass. It is the verdict of the best feeders in this country that a fattening animal should be given a liberal supply of succulent feed in its rations. This may be accomplished by grazing, or by feeding root crops, or pulp from the factory. An animal so fed gives a better carcass, the meat being firmer to the touch, more salable, more juicy, and possessing a higher flavor. This element of succulency in the ration of an animal is the secret of success in the Scotch and English feeders in the production of their fine steaks, roasts, and chops. Their example is being successfully followed throughout this country in producing meats of a higher quality to-day.

When it is considered that the pulp can be procured in many places convenient to the feed yards of the farmer for nothing, and many other places at 10 to 35 cents per ton, the suggestion of its use is emphasized. It is a common custom for a farmer to return home with a load of pulp after delivering the beets to the factory. If it is to be used immediately, it is simply piled in a convenient place and fed as desired. That for future use is placed in a silo. The most common silo for beet pulp is a large slanting trench dug in the ground, the walls of which are made of lumber, brick, or cement. Some system of drainage is desirable. After a time siloed pulp undergoes a change by fermentation, the same as any other silage; most people prefer the fermented pulp to the fresh. Any sort of covering, such as hay, straw, or boards, will complete the means of preservation. The pulp can then be drawn upon at will for stock feeding.

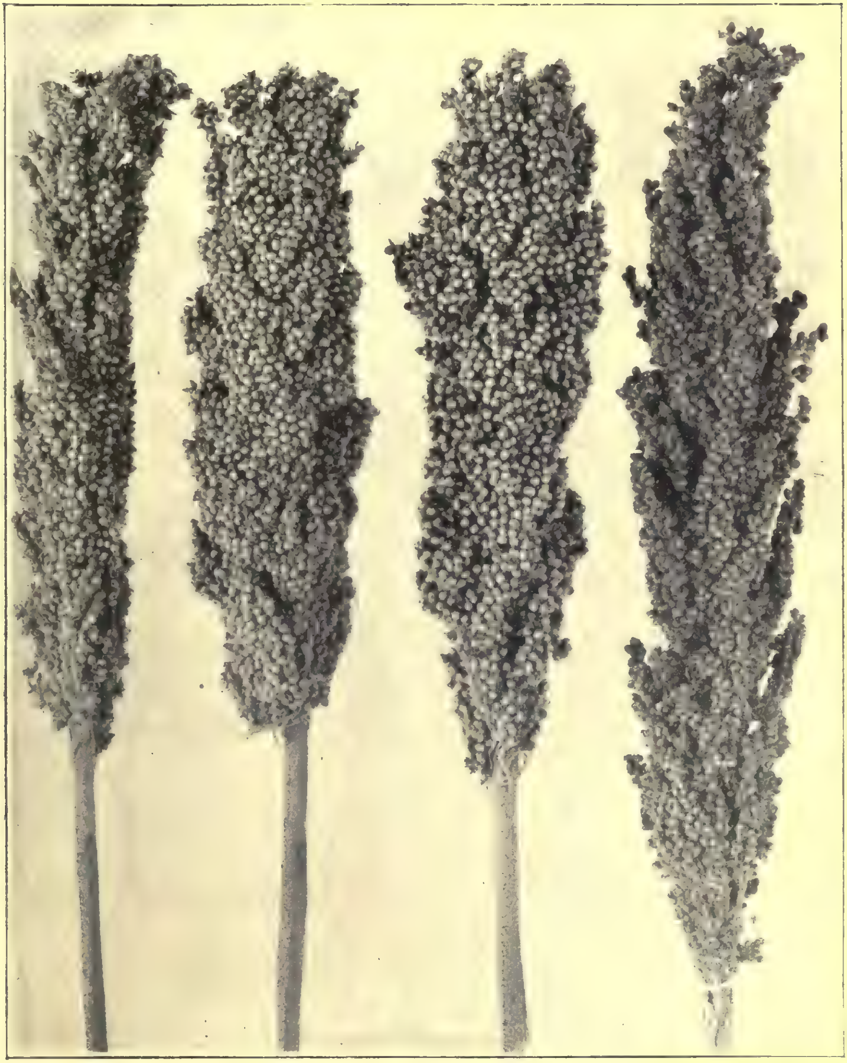
Beet pulp can be simply thrown upon the ground and preserved for three or four years without any considerable deterioration, except in the outer part. A silo can be built above ground with boards if desired. Some sort of protection is preferable to none at all.

Dried Pulp.—Dried pulp is prepared for the market usually in a subsidiary plant at the sugar factory. The preparation consists in driving off the moisture under a high temperature in a specially arranged kiln. A ton of beets usually produces half a ton of what is known as wet pulp. After the sugar is extracted from the beets the residue is either carried out to the pulp dump or it is run through a press which extracts part of the superfluous water. If pulp is allowed to stand in a dump or in a pile it naturally drains to considerable extent, thus ridding itself of superfluous liquid the same as in the press. This is the only preparation the pulp that is generally fed in this country receives. It is fed extensively in this form in the older countries of Europe. This is known as fresh pulp, and is about 90 per cent water.

Dried pulp has about the same protein content as corn, that is to say, its muscle-producing qualities are about the same. The first advantage of dry pulp is largely a mechanical one; it can be sacked and delivered to all parts of the country without the extravagance of freight charges on waste material. It is a very profitable animal food, taking the place of bran, oil meal, and other by-products used as feeds. It can be baled, compressed, and shipped long distances. In this form it extends the market for the pulp output of the sugar factories. It is customary in the older beet-sugar countries in preparing dried pulp to mix with it the waste molasses, forming a combined dried molasses-pulp stock food. The sanitary effect of this combination is considered excellent. The molasses contains ingredients tending to the healthful laxity of the animal. It also contains considerable sugar, which can be extensively used in feeding animals. The best practice is to sprinkle it on the hay, alfalfa, or roughage.

The amount that should be fed depends largely upon the animal and the purposes of feeding. The scientific food rations of Germany contain either this dried molasses-pulp food or fresh pulp. The amount is designated and differs with the size and kind of animal and the purpose of feeding.

Beet Leaves and Tops.—The proper disposal of beet leaves is a mooted question. The fact that the beet crop removes considerable fertility from the soil is one well established. To continue the process of removing without restoring it would exhaust the land. This fact is not peculiar to the beet crop, but is true of any other. In the leaves and crowns of the beets, removed in topping, is stored considerable of the fertility taken from the soil. These tops and leaves are available for general feeding purposes, and it is customary to so use them. Often they are gathered and sold in cities and towns the same as hay or straw. Everyone is agreed as to their value for animal food. In the hands of a systematic, frugal farmer they can serve the purpose both of animal nutrition and fertility. This is accomplished by collecting the barnyard manure resulting from the feeding and spreading it on the soil. If this system is followed there can be no question about the propriety of feeding the



Heads of Four Kafir Varieties. (*A*) White Kafir. (*B*) Guinea Kafir. (*C*) Blackhull Kafir. (*D*) Red Kafir. Dept. of Agr.

leaves and tops. A considerable amount of feed can be secured in this way. The combined method of feeding and fertilization is the one prevalent in Europe. Our laxity in fertilizing lands would reduce the probability of their elements of fertility ever getting back to the soil.

There are different methods of feeding these tops. The most simple method is to turn a large number of cattle in the field to consume them at once before they have had time to lose their succulency through drying; another is to allow them to cure on the ground, the same as hay, and then to store them or stack them, feeding them at will; another is to mix them in making ordinary silage, or with the pulp in the silo. The choice of method depends upon the circumstances, facilities, and the plans of the farmer. Feeding them is commendable, as the manure is returned to the soil. In the beet-sugar countries of Europe beet leaves are not only used fresh but they are often kiln-dried, the same as pulp, pressed and baled, and sent out for common consumption. In this way they lose their local use for fertility but they are a source of revenue to the farmer.

Alcohol and Vinegar.—Beet molasses contains about 50 per cent of sugars capable of fermentation. One gallon weighing about 12 pounds contains approximately 6 pounds of sugar, which will produce about 3 pints of 95 per cent alcohol. In other words, for every 2½ gallons of molasses 1 gallon of alcohol can be made.

Alcohol can be produced from whole beets at an actual cost of about ten cents per gallon, and from the waste molasses of a beet-sugar factory at a less figure.

With reference to vinegar, it is claimed that much of the vinegar now in use is made from corn which costs about $14 per ton, while the waste beet sirup costs the vinegar factory about $2 per ton, and that more vinegar can be made from a ton of molasses than from a ton of corn, and of better quality.

Other By-Products.—Considerable has been printed in the public press about discoveries of other commercial products to be obtained from the refuse of the sugar of the sugar factories. It is claimed that the pulp can be dissolved into five distinct valuable commercial commodities: Alcohol, pure carbon, glue, glycerin, and acetate of lime.—(Mes. of Pres. on B-S. Indus., 1903.)

SORGHUM.

The term "sorghum" includes all the groups popularly known in this country as sorgo or sweet sorghum, kafir, broom corn, shallu, kowliang, durra, and milo. It covers also an enormous number of cultivated forms in other lands with the possible exceptions of a few, which, as pointed out in botanical history, may perhaps be referred to *Andropogon halepensis* rather than to *A. sorghum.* In this connection the sweet sorghum only will be considered.—(B. P. I. B. 175.)

Sorghum Suited to Different Localities.—Sorghum has been cultivated in this country for fifty years, yet no general selection of the best varieties for sirup making has been made. Extensive correspondence with sirup makers in all sections shows no general preference for any variety except Early Amber for early maturing cane. In Kansas the most frequent preference is for the varieties which produce the most seed; for sorghum seed is a valuable product. The fact that sorghum has been grown long and extensively with very little selection of varieties has not been due to lack of intelligence on the part of sirup makers, but to the variable amount from year to year of the impurities in the juice of all the varieties. A variety may be selected in one season because it produces good sirup; it may be rejected the next season because it produces poor sirup. Planted early it may produce good sirup, and when planted late it may produce poor sirup in the same season and on the same soil, yet in both seasons it may produce ample and good-sirup-making material. The impurities vary in amount, according as the growing seasons are favorable or unfavorable. If the impurities are not well removed from the juice, a part remains mixed in the sirup, and so if the juice is naturally pure the sirup is pure; if the juice is impure the sirup is inferior. This variable quality of sorghum sirup will continue until sirup makers remove the impurity which causes the variations. If two samples of good wine are to be compared, to one of which impurity like that in sorghum juice has been added, then the two samples can not be rightly compared until the impurity has been well removed. The same is true of two samples of sirup from two varieties of sorghum. When both samples have been refined, so that they are equally pure, then selection can be made of the best variety, and then the excessively variable quality of sorghum sirup from year to year will be largely done away with. Removal of all the impurities from the juices of 100 varieties of sorghum would show the true quality of each, and would surely lead to the selection of a few varieties superior in flavor or other quality.

For eight years careful search was made among hundreds of varieties of sorghum for a variety which would usually give as pure juice as that from sugar cane. Such a variety has not been found. In the past three years the effort has been made to find ways of separating the excess of impurity from sorghum juice, so as to make it as pure as sugar-cane juice naturally is. There is much promise in this line of work. When that is accomplished, selection of superior varieties can be made. At present no one can rightly name the best varieties for any section or locality, except Early Amber, for early maturing cane. But three varieties are recommended, Early Amber, the best early variety; Collier, the richest in sugar; and Colman, which produces good juice, larger, shorter canes, and more seed than the others.

Soil and Climate.—The best sirup is produced where the growing seasons are uniformly favorable, neither too wet nor too dry, and on soils of moderate fertility. A good growing season, followed by a moderately dry ripening season, seems best in any section. An even and proper supply of moisture appears to be much more important than the nature of the soil. In a very dry season rich and moist lowlands often produce the best sirup. In a wet season arid and poor uplands often produce the best sirup. It is probably true that almost any soil, in any section of the country, with suitable rainfall, can produce good sirup. And it is probably also true that by separating well the colorless solution of crystallizable sugar and of uncrystallizable sugar, which sorghum juice always contains, from the vegetable impurities, good sorghum sirup can be made in any section with cane from any soil. Canes of quick growth usually produce good sirup; for, to ripen unusually soon, the entire growing season must be unusually favorable, producing naturally pure juice, and thus, naturally, pure sirup. Unfitness of sorghum juice for sirup making increases as canes become ripe or overripe. For these reasons sirup made in the far North is usually of better color, of milder flavor, and more palatable than sirup made in the South. Nebraska, Kansas, Oklahoma, and the part of Texas south of these States, produce the largest acreage of sorghum and the cheapest cane; the canes produce denser, richer juice, but often less pure, and consequently inferior sirup to that of States less subject to extremes of drought and flood. In Kansas the amount of true sirup-making material, the sum of the crystallizable and of the uncrystallizable sugar, varies less from year to year than the yield of wheat or of corn. The juice usually contains quite as much of these two sirup-making materials as Louisiana sugarcane juice, yet it often produces sirup of poor quality, because it is often loaded with slimy and suspended impurities, which are not well separated from the juice by the processes of sirup making now in use. The climate and the nature of sorghum can not be changed. Western sirup makers need to take more pains to grow good cane and to use better methods for cleaning the juice from its impurities. The generally inferior quality of Kansas sirup is not caused by the soil, for in favorable seasons it produces as good sirup as any section. It is not due to the lack of good sirup-making material in the juice, but to the excess of impurities present. When the juice is well purified it always gives good sirup. The special object of this bulletin is to show how the vegetable impurities which give sorghum sirup its dark color, rank flavor, and turbid appearance may be removed, so that better sirup may be always produced in any section or locality.

Planting, Cultivating, and Harvesting.—Securing good unmixed seed, of a good variety, is the first step toward making good sirup. A sirup maker should select typical canes of the varieties he prefers and put them in shock. The seed keeps well there, unless taken by birds or stock, and should remain until they can be attended to. When quite dry, a dozen or more of the seed heads should be put into a stout grain bag. Pounding the heads with a club quickly thrashes the seeds. The seeds may be cleaned in the wind by pouring them from one pan into another, then shaking the pan to bring stems and trash to the surface, so that they can be removed. A sirup maker may thus obtain unmixed seed of a good variety, sounder, cleaner, and better than he can buy.

Planting and Cultivating.—A pound and a half of sound seed is enough to plant an acre. A bushel weighs 56 pounds. Some varieties ripen in three months, some in four months. When harvested, canes of mixed varieties are green, ripe, or overripe—all are not in best condition for sirup making. Some varieties grow tall, some short. In topping the bundles of cane the seed heads are often left upon the short canes, causing loss of seed, and the seeds which go through the mill injure the sirup. It is therefore better to plant pure seed.

In times of drought canes planted thickly suffer more and give less pure juice. In the West most sirup makers plant too thickly. One cane in 6 inches of the row is quite enough, and with good seed one seed in each 3 or 4 inches of the row is sufficient. The planting and cultivating are often carelessly done. Cane and sugar-beet planters take vastly more pains in cultural work than sorghum growers. More care in planting and cultivating sorghum would often give a much larger yield of cane and better juice, all other expense being the same. Often much of the cane brought to Western sirup mills is more fit for fodder than for sirup manufacture. Some farmers who use the disk cultivator assert that its use is almost indispensable in growing cane; for very small plants can be cultivated with it, close to the row, without covering them, as ordinary cultivators do. It is easier and better to cultivate cane at the right times, keeping ahead of weeds. It is a German saying that sugar is made in the field. This is true also of sirup.

Harvesting.—Cane is often harvested at some convenient time, often when too green or overripe. It should be cut when in best condition for sirup. Topping the seed heads is often badly done, leaving much seed to go through the mill and into the juice. Good dyes can be made from sorghum-seed hulls, and starch from the seeds; hence the importance of keeping the juice as free as possible from these substances. The good canes only used to be stripped of leaves and brought to the sugar mill; now everything in the row—weeds, broken canes, suckers, etc.—are milled and serve to make sirup, since machine harvesters take all, and the mill grinds all. It is not economical to take excessive pains in manufacture, but it does pay to do work in a workmanlike manner—at the right time and in the right way.—(F. B. 135.)

Manufacture and Marketing of the Sirup.—The principles and methods outlined in the manufacture and marketing of sugar-cane sirup apply with equal force to the manufacture and marketing of sorghum sirup.

Dealers prefer to handle canned sirups. It is easier to take a can of measured sirup from a shelf than to leave customers and draw a slow-running sirup from a barrel. It often suits customers better to buy a can of sirup of a brand they like than to get a sirup of uncertain quality from a barrel. It seems that sirup makers should can their best sirup, always keeping the quality true to the label. Sorghum sirup made without lime or chemicals, with no adulteration, light colored, retaining the natural acids of the juice, should carry a label stating the facts. Limed sirup, a rich, warm, red color, nearly neutral, clearer and brighter, is preferred by many, and its label should state its quality. The label should bear the maker's name as a guaranty of the quality. The lower grades should be barreled and sold by sample, or inspection, as usual. A can with a seal cover is largely used by sugar-cane sirup makers. The stopper of the can carries a rubber band, for use in sealing up the hot sirup. It is claimed that sirup, sealed while hot, can be kept for years, retaining the flavor of newmade sirup, with no fermentation. It is not well to put fine sirup in leaky and stained second-hand barrels. Many manufacturers take great pains to make their goods attractive and put them in attractive packages. Sorghum-sirup makers should follow their example.—(F. B. 135.)

(*Additional References.*—Del. E. S. B. 39, 44, 51; S. C. E. S. B. 88; B. C. B. 20, 34; N. J. E. S. B. 51.)

BROOM CORN.

Although there are a number of so-called varieties being grown in various localities, the market knows but two sorts, standard and dwarf. Most of the so-called varieties are names derived from localities where broom corn has been successfully grown or seedsmen's names.

The Soil.—While the soil that will produce good crops of corn and sorghum may be depended upon for a good crop of broom corn, it is very necessary that the previous treatment be such as will as near as possible destroy the weed seeds that may be in the soil, since the presence of weeds greatly interferes with the proper cultivation of the young broom corn plants and with their early growth. Sandy or even gravelly soils are well suited to broom corn, but they must be thoroughly drained. Undrained land not only induces an irregular, slow and inferior growth but makes cultivation more difficult and causes the red color in the brush, which may reduce its market value $20 or $40 per ton. Uniformity of soil character, fertility and exposure, will induce uniformity in ripening.

The Seed.—The peculiar growth of the seed head of broom corn is abnormal and artificially developed, mainly by seed selection. Its value for the manufacture of brooms is due to the characters of the panicle associated with this induced growth. That these artificially developed characters may be reproduced and improved, careful selection of the seed is necessary, not only for one crop but for each crop. There is a constant tendency towards reversion to undesirable form, and seed from only the most desirable individual plants should be reserved for planting, if the grower produces his own seed. The majority, however, will purchase their seed of seedsmen. Unfortunately the seed business affords almost an unlimited field for fraud. The purchaser of seeds of whatsoever kind can best protect himself by dealing only with firms of established and known reputation. When the grower has become familiar with the many details of broom corn culture it will probably be to his advantage to grow his own seed if he is determined to give the matter the necessary care. If he grows his seed in an isolated patch with good soil, good cultivation and careful selection he may improve the quality of his brush. To do this it is necessary that the undesirable heads be removed before they blossom and pollenize the desirable ones, which alone should be allowed to ripen seed. It is important that broom corn grown for seed should not be planted near sorghum, since the close botanic relation of these plants permit them to cross readily, thus reducing the value of either crop grown from crossed seed.

If the seed are fresh and nine out of ten germinate, two or three quarts are sufficient to plant an acre, if a suitable seed drill is used. If the seed are dropped by hand, as is frequently the case with small growers, they are not properly distributed, there is an unavoidable waste of seed, irregular development in the resulting crop, and increased difficulties in cultivating the young plants.

Of the two classes of broom corn grown, the dwarf and the standard, the dwarf grows from 4½ to 6 feet tall and the standard from 8 to 12 feet, with longer and stronger brush than the former. These differences make it necessary that the two classes be in some respects treated differently, as will be discussed in appropriate place.

Planting.—In no case should planting begin until the soil has become thoroughly warm, since broom corn is more susceptible to cold than Indian corn, and equally as susceptible as sorghum and millet. If planted too early the seed are not only liable to rot in the soil or germinate poorly, but the plants that do appear will be weak and the stand and growth irregular. When the young plants first come up they are slender and delicate, growing very slowly the first two or three weeks. This early slowness of growth is more marked with early planting and cool weather than with later planting in warm weather. One of the most necessary and profitable operations in the growing of any crop consists in the thorough preparation of the soil before the crop is planted, and this is particularly true of broom corn. Two or three cultivations at intervals of ten or fifteen days before planting will go a great way towards the destruction of the growths of young weeds that successively spring up as the weather becomes sufficiently warm for their germination. Each shower at this season of the year will start a new crop of weeds and as soon after rain falls as the ground is dry enough for cultivation the weeder, harrow, cultivator, disc or some such surface working and weed destroying implement should go over the field with as much care and thoroughness as if the crop was already growing. This preparation—cultivation not only destroys the first few crops of weeds but gives to the soil a physical character that will manifest itself in the quick germination of the seed into strong and rapidly growing young plants, facilitating their future cultivation and growth.

Broom corn rows are usually about 3½ feet apart, though the dwarf forms may be given 4 or 6 inches less space. The distance the plants should stand in the row depends upon the fertility of the land and as to whether the dwarf or standard varieties are grown. They should be thicker on fertile land, about four plants to the foot for the standard and about six for the dwarf should be the distance for plants to occupy in the row for soil of medium fertility. On more fertile soil the stand may be thicker, and thinner on less fertile soil. If the crop is to be cultivated with the hoe the seed are planted in hills 15 to 20 inches apart with four to six stalks of standard and six to ten stalks of dwarf to the hill. A regular or uniform stand is necessary to secure a uniform quality of brush. Just such quantities of seed should be sown as will give the desired stand with as little thinning as possible. It is necessary to have the best seed and the best preparation for the attainment of this. Some broom corn growers sow a superfluous quantity of seed and thin to a stand, but thinning broom corn is a tedious and expensive task, and one that is frequently neglected, as is the case with sorghum. Corn planters with plate holes small enough for broom corn seed may be employed for planting. The seed should be covered from ½ to 1 inch deep, the depth depending upon the character of the soil and the quantity of moisture in the soil at the time of planting. If the soil is dry when the seed are sown they should be covered deeper than would be necessary if the soil was in good moist condition. Rolling the soil as the seed are planted will insure a more prompt germination and a better stand. This is particularly true when the soil is dry at seeding time. Should a heavy rain occur before the seed have germinated the field should be gone over broadcast with a weeder or harrow as soon as the soil will admit. This prevents the formation of a crust and hastens the germination of the seed.

Manuring and Fertilizing.—As to whether fertilizing broom corn will or will not pay is a matter to be determined by each grower after a careful examination into the characters and condition of the soil. Where cotton seed meal may be cheaply procured it will be an appropriate and desirable fertilizer. An application of from 200 to 400 pounds of cotton seed meal in the drill before planting, or of 75 to 160 pounds of nitrate of soda just before the first cultivation would hasten the growth of the young plants when they most needed stimulation. Fertilization that has been successful and profitable with sorghum, Kaffir corn or Indian corn would be appropriate for broom corn. A crop of cowpeas following oats, rye, wheat or Irish potatoes would improve the soil for broom corn to be planted the following spring not only by the enrichment of the soil but by being a means for aiding in the suppression of weeds. Where crimson clover does well the cowpeas may be followed by this crop. Broom corn has also been grown with success on soil from which rye and vetch and Irish potatoes had been harvested.

Cultivation.—After broom corn has attained a height of six or ten inches its cultivation need not differ from that usual with Indian corn or drilled sorghum. Its growth is then rapid and an occasional cultivation for the purpose of maintaining an earth mulch and preventing the growths of weeds that might appear is all that is necessary. To give proper cultural care while quite young is more difficult. This difficulty can, however, be greatly obviated by as far as possible ridding the soil of weeds the year previous, and by several cultivations of the area intended for broom corn before the seed are planted.

When the young plants first appear they are small and not dissimilar in appearance to young foxtail grass. Unless the soil has been made comparatively free from seeds of such weeds as crabgrass, rag weed, pig weed, foxtail and others, cultivation must begin with the appearance of the young broom corn plants and be prosecuted vigorously and frequently, or these weeds may successfully contend for the possession of the soil. It is frequently possible to go over the field once or twice with a weeder after the broom corn is planted and before it is up, thus destroying many weeds or so checking their growth as to give the more slowly germinating broom corn an equal start. Harrows, weeders and cultivators (with sidebars to protect the plant from being covered with soil) if used frequently after the young plants show along the row will greatly lessen the labor of hoeing. Old stalks of weeds, corn, sorghum, broom corn and the like will seriously interfere with the cultivation of this crop, and such trash should be gotten rid of before the broom corn is planted.

Cultivation should be of such frequency as not only to destroy all weeds before they have attained a size that would injure the broom corn or interfere with the ease of their destruction, but also to prevent the formation of a crust upon the soil surface and to maintain a high degree of tilth which will benefit the crop more than the weeds will injure. If the plants are found to be too thick the surplus should be removed when the first hoeing is done.—(Ark. E. S. B. 83.)

Harvesting.—The market demands a brush, green in color with tough, springy fiber. To obtain such a brush, the growth must have been steady and as rapid as was consistent with the nature of the crop. Checks in the growth produced by drouth or cold nights or cold spells tend to produce a brittleness in the brush which materially reduces its value. If the soil were put in good condition prior to seeding and the proper cultivation followed, the bad effects of drouth or even cold spells may usually be largely overcome. With the above factors under proper control desired color and springyness of brush can best be obtained by harvesting when the bloom or anthers are falling from the head. Of course, the seed is undeveloped at this stage and has no value for seeding purposes. It is worth something for feed and may be used as manure for the land.

Method of Harvesting. — The method of harvesting differs whether one is growing standard or dwarf broom corn. Standard broom corn usually stands eight feet or more in height. In order to harvest the brush, the stalk must be cut or bent over so that the head will be in easy reach. To do this a regular process is followed called "tabling." This is not only convenient but keeps the heads clean.

Tabling.—To table broom corn, the stalks of two adjacent rows are bent diagonally across the intervening space in such a way that the brush end of the stack above the sharp bend is supported in a horizontal position, with the brush ends extending about two feet beyond the opposite row. The height of bending varies according to the height of the broom corn, but is usually from two and a half to three feet.

In tabling the operator usually walks backward between two rows bending a few stalks first from one row then from the other. In this way a self supporting "table" is formed from each two rows, thus bringing the heads into convenient position for cutting. One man can table about as fast as two can cut. Three men will "table" and cut about two acres per day.

Cutting.—In cutting the operator walks along the spaces between the tables. A thin knife similar to a shoe knife is preferred for cutting. The brush is cut off so as to leave six to eight inches stalk on the brush. The sheath is not desired so it must be cut so as to remain on the stalk, else it must be pulled from the brush. Leaving more than eight inches of stem on the brush reduces the price. Six inches of stem is sufficient for broom making.

When cut the brush is laid, a handful at a time, on every other table. This leaves every alternate table empty so that wagons may be driven over the empty tables to gather the brush.

Dwarf corn is rarely taller than four to six feet. Thus it seldom needs to be tabled to harvest. The head of dwarf broom corn is usually partly inclosed in the sheath, often called "boot." On this account the heads of dwarf corn are usually pulled. Where the heads have a uniform state of maturity, they may be pulled and at once placed in wagons for hauling to the drying and curing sheds. Uniform maturity is greatly assisted by uniform stands and cultivation.

Rains at harvest time are more liable to injure dwarf corn than standard because the "boot," inclosing the head, may hold water about the head. This may cause the stems to redden, thus reducing their value. Under similar conditions, dwarf broom corn requires much less labor in harvesting than standard.

The yield from dwarf broom corn can be expected to be about one ton from five acres on rich lands or under irrigation. On dry land the yield will likely run around one ton from five to seven acres. As soon as cut the brush is ready to haul to the drying or curing sheds. If any considerable quantity is grown it pays to provide special dump wagons as the saving in labor will more than offset the extra cost. The wagon is driven over the empty tables and loaded by a man working from each side. The brush ends are placed out, stalk ends in and overlapping. The dump wagons slide the brush off and leave it in a pile just as it was on the wagon.

Sorting.—Before the brush is hauled in it should be sorted. Crooked or unduly coarse brush severely cuts on the market price. All such brush can best be disposed of by discarding it entirely. It will sometimes pay to have a man go ahead of the haulers and give a final sorting.

Thrashing.—If any considerable area is raised the grower will need a broom corn thrasher. The regular thrasher costs about $200. It consists of a cylinder similar to that of a regular grain thrasher. The broom corn does not pass through the beater as in thrashing grain, but is held against the beater until the seed is all removed. On the regular thrasher the brush is carried to the cylinder at an angle by means of a toothed endless belt. When the seed is removed the clean brush is deposited at the end of the machine ready to be placed in the drying sheds. To run a regular thrasher requires a force of from twelve to fifteen men. Some growers keep a sufficient force tabling, cutting and hauling to also do the thrashing. The force quits the field a little early and thrashes and stores the day's cutting in the evening.

Where only a small acreage is grown, it is sometimes thrashed by mounting a small cylinder beater in a frame. The cylinder is run with some suitable power and the brush is held in the hand in small bunches until the seed is beaten off. This is a slow process but it will answer if only a small amount of brush is at hand. Care must be taken to get all of the seed off of the brush or the price will be materially reduced.

Drying.—The market demands brush of a bright, natural green color. To retain the color the brush must be dried in sheds which will keep off the strong, direct light of the sun. At the same time it must be dried rapidly. The main requirements are a good roof, with eaves projecting several feet and good ventilation in all parts of the shed. A drying shed large enough to accommodate 40 acres would need to be at least 48 feet long by 16 feet wide by 10 high. The following internal arrangement is recommended: "Place uprights, 8 feet apart in each direction, and nail to these, 4 inches apart, this plan gives six transverse sections, each 8 feet wide, with ends open for circulation of air. Slats, 2 inches wide and 8 feet long, are required in large numbers, but are not put in place until the filling of the shed with brush is begun.

For a shed of the size mentioned above 2,200 such slats are needed. Beginning at the bottom a shelf is formed by placing two of these movable slats across a section, resting their ends in the lowest spaces between the transverse strips nailed to the uprights. The brush is then evenly spread two inches deep upon these two slats, and then another shelf is made 4 inches above the first, and so on, till the shed is filled. If placed more than three inches deep the brush will not dry quickly and well, and may become musty or shed burned.

Rain or dew on the brush while drying is liable to tinge the brush red which injures its market value. Rain and bright sunshine will often produce brittleness in the brush which also reduces the price.

Bulking.—Although protected from inclement weather by the shed, dry weather cures the crop much better than damp weather. If the weather is dry, the curing process takes from two to four weeks. The end of the process can be determined by examination of the stems. If no moisture shows on twisting the stems, they may be considered cured. They should be taken off the drying rack at once and piled in straight regular piles to prevent undue bleaching.

Baling.—Baling consists in pressing the brush into bales, by means of a baling press, and binding with wire. Broom corn manufacturers will not accept poorly thrashed or baled brush. The brush should be left bulked until all dampness disappears. A hand press may do where only a small amount is produced. But if any considerably quantity is grown some form of power press will be required. The bales are usually tied with large wire, which injures the brush less than fine wire. Bales usually weigh about 350 pounds when they arrive in market. One power baler will work about eight men and bale around ten tons per day.

Marketing.—The prices vary according to supply and demand. Good, first quality brush can always be sold. Off color brush, bleached, musty, crooked, coarse, brittle or poorly cleaned brush is always lower in price and often cannot be sold at all. When broom corn is very scarce, manufacturers will sometimes buy brush that would be rejected at any other time. But even in such times it sells at a price much lower than good quality brush. The following market grades are recognized: Common, partly off color, red-stained and bleached, self-working. Fair grade, slightly off color, self-working. Good color and good fiber, self-working. Fine fiber, dwarf, red tipped. Fine fiber, dwarf, running well for whisk brooms. Fair, crooked. Good, well-handled, crooked. Fair, medium, red-tipped. Slightly tipped, smooth growth. Good, green, smooth, self-working. Choice, green, self-working, carpet stock. Fair, medium, sound hurl. Good, medium hurl. Good, green, smooth, carpet hurl. Choice, green, smooth, carpet hurl.

Conclusions.—Broom corn is quite drouth resistant and is consequently adapted for Colorado plains. Inexperienced growers should only attempt a small area at first until they have learned the requirements of the crop. Good seed must be obtained. This can be done best by each grower producing and caring for his own seed. To raise any considerable acreage requires sheds and shed equipment, dump wagons, baler, thrasher, and a number of small items. These will probably cost from $1,200 to $1,500 and up. The equipment will last several years if properly cared for. Broom corn may be profitable under dry farming, but it will seldom pay under irrigation. To succeed with broom corn it should occupy a regular place in the rotation and uniform acreage planted from year to year. Checks in the growth due to cold or drouth produce a tendency to brittleness. Wetting by rain or dew and drying tend to produce brittleness and red-tinged brush. Strong light bleaches and gives uneven color. To produce a good quality of brush takes care, but it brings good prices.—(Colo. E. S. Cir. 9, 1910.)

Additional References.—(Ill E. S. Cir. 18; Y. B. 1901.)

SUGAR CANE.

Sugar cane belongs to the family of grasses; and most authorities are inclined to trace all the different kinds of sugar cane now grown to a single species, *saccharum officinarum.* According to this, all the different sorts of cane now met with are induced by the effects of cultivation. But there is no absolute unanimity of opinion upon this subject. For practical purposes we may divide the canes into three principal varieties—the red or purple cane, the ribbon cane, and the green cane. The red cane is the hardiest variety; will resist cold and drouth better, and is perhaps a little richer in saccharine matter at early cutting; although there is little difference between it and ribbon cane in this respect. The green cane appears to be rich in juice, but is later maturing, and is, therefore, liable not to be so sweet as the other varieties. It is, however, a softer cane—easier to crush—and this is a property worth considering when horse-power mills are used. But the red cane, on account of its power to withstand drouth and cold, is recommended.

Improvements of Varieties.—According to Deerr, some of the methods for improving cane may be classified as follows: (a) By importing new varieties. (b) By selection of tops for planting from canes of high saccharine strength. (c) By raising new varieties by means of the seeds of the cane. With regard to the first method, it must be remembered that the cane plant adapts itself very slowly to new surroundings. A variety that is good in one locality may not prove itself of value in another; but like other plants, the cane can be improved by "continuous careful cultivation." The importation of new varieties has not generally given gratifying results. In regard to the second method of improvement, there seems to be no uniformity of opinion among authorities as to its definite value. The third method has given satisfactory results, after many disappointments. Of course this improvement of varieties is not so important to the syrup maker as it is to the sugar manufacturer. But even in syrup making, it is not to be overlooked or neglected, since varieties may influence the ease with which the juice is subsequently handled.

Soil.—There are three conditions which a good cane soil should possess—good drainage; fertility; the capacity to retain moisture. These conditions are found mainly in our alluvial soils when properly drained. They vary from a sandy loam to a stiff clay. The clays, when well drained and properly cultivated, usually give a heavier tonnage to the acre, while the lighter lands yield a cane richer in sugar. A clay loam is perhaps the best cane land. It is comparatively easy to work, fertile, retentive of moisture, and yields a cane rich in sugar. In the manufacture of syrup, however, it is more important to have a heavy yield of cane than that the cane be especially rich in sugar. Of course, under irrigation, the question of the retentive power of the soil for moisture is not so important.

Preparation of the Soil.—It can not be too strongly impressed upon the mind of the cane planter, however small or large the acreage put in, that his land must be thoroughly drained. Plant-cane, stubble-cane, nor cane in windrow, will not permit continued contact with sub-soil water. Once get the land thoroughly drained, and the next important consideration is to get it thoroughly pulverized to as great depth as practicable. The land should be broken up in the fall and go through the winter in good condition; at least come out so in the spring. If the land is poor, it must be fertilized if good crops are expected.

Planting.—The very best farmers are not yet agreed as to whether it is best to plant in the fall or in the spring. The fall is preferable in localities so far north that the cane does not have full time for maturity. Planted in fall, the cane comes up earlier in the spring, and, of course, permits of earlier grinding. At the same time, more care is necessary to protect the cane from frost during the winter months. "Plant-cane" is not so easily protected from the cold, as when in windrow or bed. The ground should first be broken broadcast—preferably with a disc plow; on account of its giving a more perfect pulverization, and the burial of any trash or vegetation. Then take a two-horse turning plow and put up the best beds possible, cleaning out the middles so as to leave unobstructed drainage to the ditch or quarter drains. When ready to plant, from the last of September to the middle of October, take a turning plow and open up the top of the bed, throwing the dirt both ways, going to a depth of about 6 inches. In this trench—the bottom of which should be above the level of the middles between the rows—plant the cane, and cover to a depth of at least six inches to keep out the cold of winter; the eye of the cane being very sensitive. The cane should only be cut in pieces short enough to admit of a straight row. If the cane is very crooked, of course it must be cut in shorter lengths to give this straight drill. But it is a mistake to cut straight cane in short pieces; or to cut it at all, if it can be avoided. The cane can be planted stripped or unstripped, and it is safer to put two running stalks together; although a good stand may sometimes be had from one running stalk, by allowing the ends to lap at least 6 inches. It should be remembered that the tops of the cane will do for planting; and at time of grinding, these may be kept for that purpose.

Cultivation.—When the cane first starts to coming up the planter may feel very much discouraged over the absence of a stand. But the disappointment is probably not justified. One shoot to every foot may be considered a good stand, since the stalk has great power for suckering, and will soon add to a stand that at first was very unpromising. There is likely to be an ultimate stand of three to six canes to the foot from planting two running stalks as above indicated. During the early season, the cane suckers freely, and many of these suckers are likely to die down later on. But if there remains three good canes to the linear foot, the crop may be considered a very satisfactory one. If the cane comes up thick from the start, it is likely to sucker excessively and become too thick, so it is well to aid the start of what suckers are wanted early in the season, and then cultivate to suppress additional ones. The experienced cane planter attempts to prevent excessive suckering by close cultivation; but, of course, this should not be close enough to cut the roots of the cane. Suckers appearing after the middle of June are not likely to mature, even when the rainfall happens to be pretty well distributed and the soil well adapted to cane. It is more than likely that the locality, north or south, from which the seed cane is obtained, will exert an influence upon the date of its maturity. Early in the spring—as soon as danger of frost is over—the cane should be barred off, and the top of the ridge removed with hoes to allow the young shoots to come out. Care should be exercised at this time in order that a good stand may be secured. When the cane is large enough, the middle may be broken out, throwing a good bed to the cane, and leaving a clean, clear middle furrow to facilitate drainage during the spring rains. While the cane needs a large amount of water for full development, it can not, as stated above, endure standing sub-soil water in actual contact with the roots. It is the practice with many farmers to use the turning plow for cultivation from this time on to laying by, or last working. For small acreage, sweeps may be used to advantage when cultivators are not already on hand. Of course, the season will exert some influence on the manner of cultivation. It is necessary to keep in mind that in the cultivation of cane, a good bed should be maintained, up to the latter part of the season at least; and that frequent and shallow cultivation greatly retards the escape of moisture from the ground. Be careful to see that the ground is in good mechanical condition, and not too dry, at the time of planting. From first to last, during the time of cultivation, the soil should be kept in good tilth. Cane should not be planted in the fall when the ground is too dry, since "dry rot" is liable to occur; and it needs good drainage rather than rich land; but a large crop can not be obtained except on fertile land. About four tons of stripped cane will be required to plant one acre.

When Shall the Cane Be Cut?—It is desirable, of course, to allow the cane to stand as long as possible and still escape a killing frost. For syrup manufacture, cane which has had its tops killed by a light frost may still be used; although it will be more difficult to clarify. And if the cane is cut and moved under a shed, it will keep for weeks unless caught by a freeze. Plant-cane, which is cut too early in order to work off a late crop, leaves a stubble which is liable to sprout the same fall, and thus injure the stand of the next year's crop. It is therefore, best to cut the oldest stubble first, leaving the plant-cane stubble until the last.

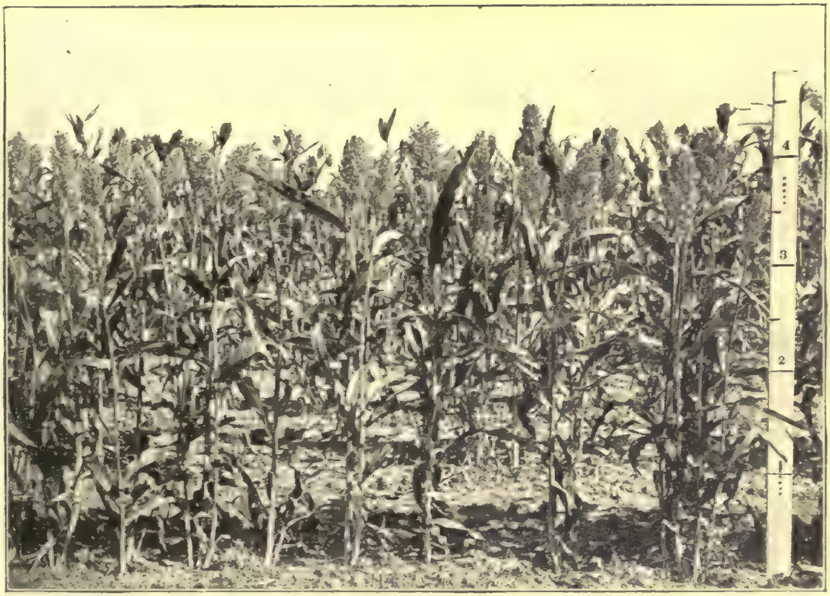
Yield of Cane and Sirup to Acre.—The richer the land, other things being equal, the heavier, of course, the yield of cane; but it is not so rich in sugar, and usually yields a juice which is more difficult to clarify. Cane contains about 90 per cent of juice; but only 78 to 85 per cent of this is extracted by even the best and latest improved sugar mills. A small syrup mill would not extract more than 60 to 65 per cent. A ton of cane may be expected to yield from 16 to 20 gallons of finished syrup; say an average of 18 gallons, and 25 tons of cane per acre, making 450 gallons of syrup, which, at 25 cents a gallon, ought to yield a very handsome profit to the farmer.

The Manufacture of the Sirup.—This may be done in the most primitive way. In fact nothing more is required than what is known as a "sorghum mill." This consists of three small iron rollers with a crank to which a wooden lever is attached, pulled by one or two horses; and in addition to the rollers, an evaporating pan, which can be mounted in a crude way on masonry over a furnace. This simple outfit is too well known to need description. But the best grade of sirup can not be made in this way for the following reasons: (1) The heat can not be properly controlled with an open or direct fire; steam heat should be used instead. (2) A product of even grade can not be obtained. The precise completion of the product for different runs from the evaporator can not be made by guess work. Some means must be provided for taking the specific gravity, or weight, of each "run." (3) This primitive method does not provide for the removal of the dirt, except that which collects in the scums and is removed with it. (4) Clarification is not complete. The skimming may be very carefully and patiently done, but without liming, the scums are not completely separated from the juice, and can not, therefore, be removed.

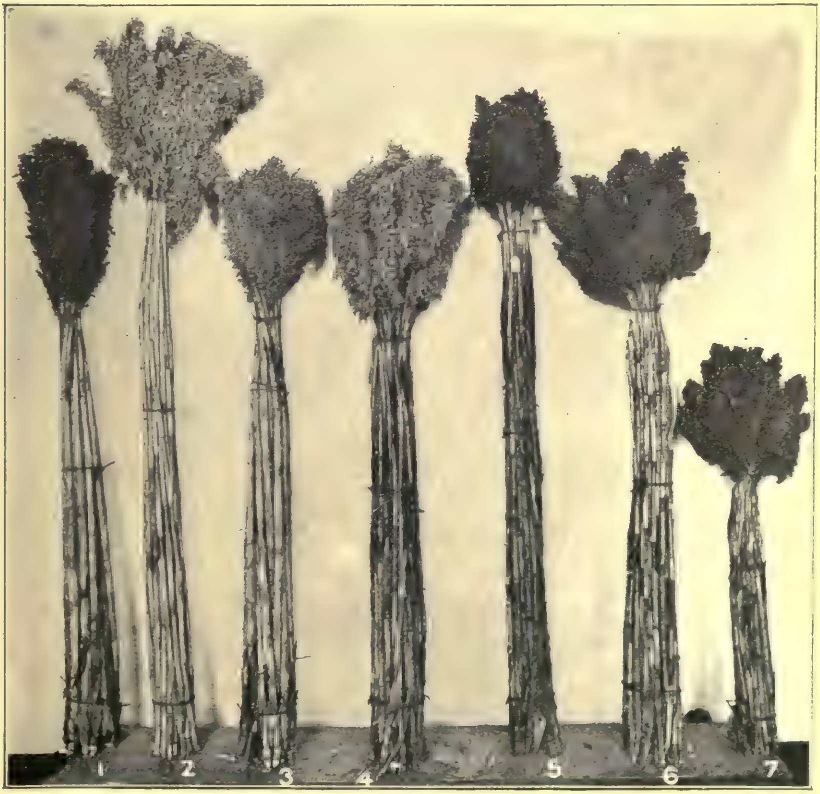
But fortunately most of these difficulties can be overcome with very little expense, or increased cost. Steam heat may be dispensed with, although a uniformly-cooked product is not likely to be obtained throughout the season, and certainly not from year to year. No matter how careful, some one "run" is sure to be more or less scorched. But the specific gravity can be easily taken with a simple and inexpensive hydrometer. Take a straight, dry, thoroughly-seasoned hardwood stick, about one-quarter of an inch in diameter, and from 12 to 15 inches long. Roll a narrow piece of sheet lead around one end of the stick, or introduce a few shot into a hollow in the bottom of the same. A straight piece of "switch cane" with the upper joints punched out or burnt out, leaving one lower joint for holding the shot, makes a splendid hydrometer. The size of the cane may be as much as one-half inch in diameter. This gives the hydrometer—an instrument used for getting the weight or specific gravity of liquids as compared to water. But it must be graduated, or marked, in such a way that when dropped into a liquid it will show its comparative weight. For this purpose drop the stick or cane into a bottle filled with sirup which has been heated to the boiling point, and regulate the amount of lead on the stick in such a way that the stick stands upright, its lower end being about 2 inches from the bottom of the bottle, with about the same amount of stick projecting above the top of the liquid. Note carefully the surface contact of the stick with the top of the syrup in the bottle, and at this place make a little notch on the hydrometer, or "syrup tester." After the notch is made, verify its accuracy by dropping the "tester" back into the sirup, and see that the notch exactly cuts the surface of the liquid. A black thread may then be tied around the stick, or "tester," at the notch to make it more easily seen. It is well to keep on hand at least two of these "testers" at a time, so that if one is broken or mislaid the other will be ready for use. When making a run of sirup, and when in the judgment of the boiler it has reached the right density, or is "done," a sample should be withdrawn, and its specific gravity tested while hot. When the "tester" shows it of the right specific gravity it is immediately withdrawn. In this way, sirup of uniform density can not only be made during the season, but from year to year. Glass hydrometers, or "saccharometers," as they are called when used for sugar solutions, can be had of any chemical supply house, through the local druggist. They cost about 50 cents each. Ask for Beaume's hydrometer for liquids heavier than water, graduated from 0—40 degrees, divided into single degrees. Sirup of the proper density should register 33½ to 34 degrees on this hydrometer, tested while near the boiling point. When the syrup has cooled to the ordinary temperature it should register 40 degrees Beaume. Having arranged for accurately gauging the specific gravity of the sirup, the next step is to decide whether or not the juice shall be limed and sulphured. In case it is not, it must be carefully strained or filtered through some material that will not only take out the suspended or mechanical impurities, but that will also improve the color of the juice, or partially bleach it, and remove from it some dissolved solids that are not sugar. In other words, it must in some degree at least take the place of sulphuring and liming the juice, which have for their object the bleaching and removal of dissolved impurities. Several substances have been tried for this: Excelsior, straw, hay, charcoal, sand, shavings, etc., but Spanish or gray moss is by far the best material. In localities where this can be used, it can take the place of lime and sulphur, though it is not quite so effectual.

The Use of Spanish or Gray Moss.—The moss should be collected, hand-picked, to free it of foreign matter, and then thoroughly washed, and lightly scalded with water. It is then tightly packed in a half-barrel connected at the bottom with the supply pipe to the skimming pan. The barrel is placed so that it catches the juice as it runs from the mill, the juice filters through the moss and goes directly to the skimming pan. The second day, before beginning the run, the moss should be removed and put in a tub and well scalded, to correct any sourness or fermentation that may have set up during the night. The moss may be used in this way day after day until it begins to clog, and fails to remove the color from the fresh juice as it comes from the mill, which will usually be the second or third day, when fresh moss must be supplied. It is safer to collect fresh moss every other day.

The Use of Sulphur and Lime.—When gray moss can not be obtained, or when it is desirable to make sirup of a little higher grade, or on a larger scale, it becomes necessary to treat the juice with the fumes of sulphur, and subsequently with slaked lime. The object of this combined treatment is to remove dissolved impurities from the juice, and somewhat bleach it at the same time, giving a clearer, lighter colored sirup. The juice of the cane has a slight acid reaction or test, and this acid condition should never be entirely neutralized; if it should be, the keeping quality of the sirup is impaired, and the sirup darkened at the same time. Burning sulphur gives a gas which shows an *acid* test, and slaked lime shows an *alkali* test, such as that characteristic of wood ashes. The first step is the construction of the sulphur furnace, for which any kind of crude masonry enclosing three sides, with a wooden flue attached, will prove sufficient. A small fire is lighted in the furnace, and roll sulphur added as needed to keep up copious fumes, which are



Plat of White Durra with 100% of Heads Erect. Dept. of Agr.



Sheaves of Improved Grain Sorghums. 1. Red Kafir. 2. Shallu. 3. Blackhull Kafir. 4. White Durra. 5. Brown Kowliang. 6. Milo. 7. Dwarf Milo. Dept. of Agr.

conducted to the sulphur box. This is a long narrow box with perforated wooden shelves through it, so placed that as the sulphur fumes come in at the bottom, they will meet the juice as it falls in a spray delivered at the top. From the sulphur box the juice goes to the storage tank, and from there is drawn directly to the first cooking pan, of which there may be only one, but should be three. In this pan, whether the first of three, or the only one used, the juice is limed. The quantity of lime added will vary somewhat, with the ripeness and condition of the cane. The lime is slaked to a paste, and if the cane is somewhat green, some 290 cubic inches of this paste is added. If the cane is fully ripe, 215 cubic inches will be sufficient. In the former case, when an excess of lime was added in order to secure clarification, the excess is corrected by the addition of a small amount of sulphurous acid or dilute phosphoric acid, known to the trade as "clariphos." This second acid treatment prevents the formation of dark-colored compounds in the sirup by the union of the lime with the glucose sugar of the juice. From one quart to one-half gallon of clariphos will be required for every 300 gallons of juice that has received the lime treatment. When most of the scum arises to the surface and is removed, the juice goes to the next or second pan, where it is still further heated, and any light scum removed. With steam heat, the juice in first and second pans can usually be freed of scum and ready for transferring to strike pan, in about one hour. The preliminary boiling and removal of scums is shown to be about complete, when a small bottle (two to four ounce) of syrup is removed, and the sediment in it settles quickly. The clarified sirup, if more than one pan is used, is then drawn off by gravity into settling tanks, where it is allowed to stand some time for the separation of sediment. From the settling tank it is carried back to the storage tank, and from there to the "strike" or "cooking pan." Here it slowly cooks and boils into a strong foam, and the experienced eye can tell whether or not it has received the proper treatment in the previous pans. If the bubbles are large and high, they indicate that hardly enough lime has been used in the process of clarification. But if the bubbles are small and low it indicates an excess of lime remaining in the sirup. When the bubbles are bright and clear and of medium size, they indicate that the skimming has been good. As the foam rises to the surface in the strike pan it brings with it most of the scum remaining in the juice; this is swept off with a wooden paddle into the catch all, which is a trough running around the rim of the pan. The scum rises as a dark covering or cloud on the surface of the bubbles. This foam and covering is swept off as explained above, rather than any attempt being made at skimming; it goes from the catch all by a pipe into a storage tank below, and finally back into the clarifiers to be reworked. As the finished sirup leaves the strike pan it is usually passed into long cypress troughs, where it is allowed to cool and settle, before being barrelled. But this is not by any means the best practice.

The sirup, after being made, should be allowed to settle in long narrow boxes set upright. If this is done, it not only frees the sirup of any remaining dirt and sediment, but eliminates the necessity of filter press, which is expensive, and not so good as the settling process. All sirup which has not been filter pressed, an expensive process, will contain more or less sediment, which can easily be removed by narrow, upright settling tanks. These should be not less than 8 feet high, preferably 10 feet, and not more than 18 inches in diameter. Bibs can be supplied near the bottom for drawing off the syrup above the sediment, when a clear, uniform product can be obtained. The sirup containing the sediment can be drawn off from below, and either reworked in the "strike pan" or sold direct as a second grade product.

Use of Litmus Paper.—There are two kinds of litmus paper, and they can both be obtained through any druggist. The blue paper is turned red by any acid solution, even when the acid solution is very weak. The red paper, on the other hand, is turned blue by any alkaline solution. It has previously been mentioned that the freshly expressed and untreated juice of the cane has an acid reaction; the effect of treating it with sulphur fumes is to still further increase this acidity. The treatment with lime not only precipitates or throws down, of itself, some of the dissolved solids in the juice, but unites with an excess of acid if present, and carries down impurities in a mechanical way. But in treating the juice with the lime paste, the litmus paper should be frequently used, in order that an excess of lime may not entirely neutralize the acid and render the juice alkaline. If this should occur, some sulphurous acid or phosphoric acid must be added immediately until the juice has a faint acidity.

Use of the Lime.—About one barrel of lime is slaked at one time in a box conveniently located with reference to the clarifying pan. Then a small box, about 6x6x6 inches, with 216 cubic inches capacity, will be found a very convenient measure for putting the lime into the clarifier.

The Evaporating Pans.—The evaporating pans may be of any convenient size and shape. Pans 6 feet in diameter and 30 inches high will be found to be a very convenient size and form for steam heat. They should be of copper, but steel will answer quite well.

Size of Mill.—A 100-ton mill will give about 2,000 gallons of sirup a day, if the steam supply is sufficient for running the mill and heating the sirup at the same time. But this is larger than is necessary for any one farm; such a mill might be used as a central or co-operative one for several farms. A 50-ton mill is even larger than is ordinarily required. But the boiler capacity, when steam is used for evaporating the juice, should be at least double that required for running the mill alone.

Cane Sirup as a Commercial Commodity.—One great obstacle in the way of putting the manufacture of cane sirup upon a commercial basis has been the difficulty of getting the sirup to keep properly. Either the sirup would crystallize in winter, leaving a considerable deposit of brown sugar; or, failing to do this, it would ferment, "work," in summer, and finally sour, unless reboiled. It has, therefore, been difficult to sell the sirup to merchants, because of this trouble and loss incurred in handling it. But it is not necessary that either of these conditions should occur, if the sirup is made just right. The essential step toward avoiding them is to have some means of taking the specific gravity or density of the sirup, as already pointed out. Have this density 33½ or 34 degrees Beaume, when just removed from the boiling pan, or 40 degrees Beaume, when the sirup is cold. The next important step is to see that the sirup retains a slight acidity—it need only barely turn blue litmus paper red after remaining in the sirup one minute—and this acidity should be due preferably to a trace of free sulphurous acid, which is made by simply passing sulphur fumes into water. An excess of lime must not remain in the sirup; it not only turns it dark, but injures its keeping qualities. It is by leaving a slight excess of a sulphide, or of sulphurous acid in glucose sirup, that the manufacturer protects it from fermentation.

Then again, when cane sirup is stored, whether in bottle, jug, keg, or barrel, it should be exposed to the air as little as possible. If in keg or barrel, this should not be disturbed any more than is absolutely necessary. The best plan is to put up that which can be immediately disposed of, or which is to be immediately used, in small quantities, not to exceed five gallon kegs, preferably in one or two gallon cans or jugs. The barrels, when opened, should then be divided out in small quantities in the same way.—(Tex. E. S. B. 68.)

As to the commercial value of the marketing method followed a few facts are important. The common sirup of the farm, if put up in barrels, will sell at a much less rate per gallon than if put in smaller containers. Shipments of sirups in cans will net about fifty cents per gallon, the cost of the can being about ten cents each, though larger quantities will cost less. The average marketing price per gallon, if the sirup is put in barrels, will be about twenty-five cents. Between the profits of the two methods there can be no question. The process of marketing in small containers, preferably tin cans, has been put to the test of actual remunerative returns, and can be recommended to others without hesitation or reservation.—(Fla. E. S. B. 44.)

The Home Manufacture of Sugar.—The foregoing is devoted essentially to the interests of the average farmer rather than to the consideration of exceptional conditions. So far, therefore, as it can touch upon the question of sugar production it will deal solely with the domestic phase of the industry in the hope of enabling intelligent growers of sugar cane to utilize a portion of the same for more economically and satisfactorily supplying their own home and local requirements. It must be borne in mind that all that has thus far been recorded pertaining to the growing of cane and the making of syrup is equally applicable when the ultimate end in view is sugar rather than syrup, the essential difference being that the process is continued farther. The Spanish moss, double-pan method recommended for syrup is also equally applicable and commendable for sugar.

Boiling for Sugar.—After the syrup stage has been reached, if sugar is desired, great care should be exercised that all danger from scorching or overheating may be avoided. Indeed, the lower the temperature, the less the actual amount of boiling till the density necessary for sugar forming is reached, the better. High temperature and vigorous boiling having a tendency to invert the sugar and thus prevent crystallization, should be carefully guarded against. Indeed, so important is this fact that the crude iron kettle, with all its faults, possesses some advantage as the finishing receptacle in sugar boiling because of the less surface exposed to direct heat and consequently the diminished danger from over boiling. After the syrup stage has been reached, as determined by the improvised "syrup tester," the process should be continued according to temperature for twenty or thirty minutes, at which time the density should have proceeded about one-tenth beyond the syrup stage. In other words, the volume of the syrup should have been diminished by about one-tenth.

The final test for determining when the proper consistency has arrived does not rest entirely upon density or thickness, and therefore the saccharometer is useless. The test must be the actual crystallization of the sugar. If, however, a sample of syrup is found to grain and it then be tested with the "syrup tester" and an additional or lower mark be placed upon the stem of the same, this will serve as the safest indicator of the proper time to stop boiling for future runs.

When the syrup has been condensed, as mentioned, it should be removed to a barrel, tub or trough, or where a kettle is used it may be allowed to remain in the same after withdrawal of the fire.

Graining.—The condensed syrup is now ready for graining or crystallization, which process will inevitably take place in it, but may be advantageously hastened by stirring the mass while cooling with a stick or wooden paddle. Not only is the process of crystallization or sugar formation thus hastened, but the quality of the product, particularly its degree of whiteness, is very materially improved thereby. The time which will be required for completing this graining process will depend upon density, amount of impurities present and the relative sucrose or sugar content of the syrup. With reasonable success in quality, the period, however, should rarely continue over one hour, and may be completed in a very few minutes. When the graining or crystallizing has been thus affected the process is, for the time being, at an end.

Purging.—The soft sugar thus formed is a mixture of sugar and molasses, and the next step in the process is the separation of these two constituents. This is best and most simply effected by turning the soft mass, the so-called *masse cuit,* into flour barrels, through the bottom of each of which three or four one-inch auger holes have been bored, into each of which a stalk of cane as long as the barrel and from which three peelings have been taken their entire length, should be thrust. The barrels filled with the *masse cuit* should then be placed on blocks, benches or tables so that they are raised sufficiently from the floor or ground to allow the placing of a pan, tub, or crock under each barrel for catching the molasses as it runs off. Time alone will now complete the process, the purging going on by gravity without human assistance. It is complete when the molasses has so drained off as to leave the sugar reasonably dry and free from all sticky tendency.

If the process is successful such sugar will be of a light brown or yellowish color, and thoroughly adapted to most domestic uses, and will find ready sale for local consumption, or for refining.

Whitening the Sugar.—The demand of the market and perhaps, unfortunately, of most consumers is for sugar entirely free from all natural cane flavor or taste and perfectly white in color—in other words, the "granulated" form of commerce. This product, however, is the result of the refining process involving the use of complicated machinery and great capital. There are, however, simpler means by which, on a small scale with a moderate expense, the sugar may be so materially whitened as to approach the character of granulated sugar and find more ready sale. The simplest of these methods is one based on a modification of an old process used in the days when loaf sugar was a standard article of commerce. It consists simply in removing the sugar from the purging barrel and placing it in a tub or half-barrel with an outlet at the bottom. The sugar is then covered by a single thickness of common cheese cloth, on top of which is placed a water bucketful of moist clay stirred to a thick paste. The result will be that the sugar will absorb the moisture from the clay and become washed thereby; in a few days' time the sugar will have become so materially whitened as to better meet the popular demands, indeed, will approach in character and appearance the very best product of commercial sugar below the grade of "granulated."

A modification of this method may be advantageously used, based on the practice in many sugar refineries and in all laundries, viz.: Blue is optically complementary to yellow and, consequently where blue and yellow are brought together in opposition, the neutral or white optical effect follows. Consequently, the laundress uses bluing with yellow clothing to make it appear white, and the sugar refiner uses ultra marine upon his yellow sugar whereby it appears white. Ultra marine is wholly harmless and inexpensive, and can be secured of most druggists. If the water, therefore, that is used for mixing with the clay is *very slightly blued* by the introduction of a little powdered ultramarine the effect is an apparently white sugar really no purer or whiter than the yellow article, but which meets the public demand and sells for a better price.

Returns from Sirup and Sugar.—The final value of any crop must rest upon its commercial returns, whether the same is actually placed upon the market or is used for home consumption, since in the latter case, expenditure is prevented and "a penny saved is a penny earned." In the particular case of sugar cane, however, it has been, as already expressed, the desire to show that the growing of cane for the manufacture of sugar offered a remunerative crop and therefore a most valuable substitute in regular farm practice for other staple crops which have been unremunerative. The yields and value of the returns from a crop of cane, therefore, are of particular interest. From experience and replies received from letters sent to many cane growers indications are that 500 gallons of syrup per acre is a reasonable product which may, with intelligent management, be counted on as almost certain, while exceptional crops are known to sometimes return fully twice this quantity of syrup. Such syrup as described and shown can be easily made with certainty and finds constant and ready demand in the market at a net return of 25 cents per gallon, or a gross return of $125 per acre of cane. This acre of cane can be grown, and its product can be manufactured into syrup at an average cost of $75 per acre, leaving a net profit on a very moderate basis of $50 per acre from the crop. The same syrup if marketed as sugar will easily double the returns.

If sugar is the product in which the crop is finally marketed, an estimate made on the same basis and from the same data will place the reasonable yield at 3,000 pounds of sugar per acre with the simple domestic methods described. This sugar finds ready sale at 4½ cents per pound net, or a gross return of $135 per acre. In addition to this the molasses obtained must be taken into consideration, although its quality does not give it a fixed commercial status. The expense of producing sugar is nearly one-tenth greater than that of making syrup, or $82 per acre, leaving a net profit per acre of cane manufactured into sugar of $42. Although it, therefore, appears that the crop is more profitable when converted into syrup than when manufactured into sugar, still the combination of the two is commendable, at least to the extent of supplying home demand. It will, therefore, be seen that the sugar cane crop on a purely commercial basis can be made one of the most profitable resources of the Southern farmer, aside from the advantage of domestic independence.—(Fla. E. S. B. 44.)

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